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ARTICLE I.—THE MYXOMYCETES OF THE MIAMI VALLEY, OHIO.

BY A. P. MORGAN.

Fourth Paper.

(Read May 6, 1896.)

ORDER VIII. PHYSARACEÆ.

Sporangia simple and stipitate or sessile, sometimes plasmodiocarp, rarely combined into an aethalium; the wall a thin membrane, usually with an outer layer of minute roundish granules of lime. Stipe present or often wanting, seldom prolonged within the sporangium as a columella. Capillitium consisting of slender tubules, which branch repeatedly in every direction and anastomose to form an intricate network, the extremities attached on all sides to the wall of the sporangium; the tubules more or less expanded at the angles of the network and inclosing minute roundish granules of lime, these granules either aggregated into nodules with intervening empty spaces or more rarely distributed throughout their entire length. Spores globose, very rarely ellipsoidal, violaceous.

This order is at once distinguished from the Didymiaceæ by the presence of the granules of lime in the capillitium.

PRINTED AUGUST 23, 1896.

TABLE OF GENERA OF PHYSARACEÆ.

I. Tubules of the capillitium having the granules of lime in them aggregated into roundish or angular nodules, with intervening empty spaces.

A. Outer surface of the sporangium destitute of lime.

1. ANGIORIDIUM. Plasmodiocarp laterally compressed, splitting regularly into two valves.

2. CIENKOWSKIA. Plasmodiocarp terete, elongated, irregularly dehiscent.

3. LEOCARPUS. Sporangia subglobose or obovoid, stipitate or sessile.

B. Outer surface of the sporangium invested with granules of lime.

a. Stipe prolonged within the sporangium as a columella.

4. PHYSARELLA. Sporangium oblong, stipitate, the apex re-entrant.

5. CYTIDIUM. Sporangium globose, stipitate, the apex convex.

b. Stipe never entering the sporangium.

6. CRATERIUM. Sporangium obovoid to cylindric, stipitate.

7. PHYSARUM. Sporangium globose, depressed globose or irregular, stipitate or sessile.

8. FULIGO. Aethalium a compound plasmodiocarp.

II. Tubules of the capillitium with the granules of lime in them distributed throughout their entire length.

9. BADHAMIA. Stipe not prolonged within the sporangium as a columella.

10. SCYPHIUM. Stipe entering the sporangium and prolonged within it as a columella.

I. ANGIORIDIUM Grev. Plasmodiocarp laterally compressed, more or less elongated and flexuous, attached by the lower margin to the substratum, and, at maturity, regularly dehiscent along the upper margin by a longitudinal fissure; the wall a firm membrane, with the granules of lime forming a reticulate layer on the inner surface. Capillitium a loose, irregular net-work of tubules, extending from side to side, and containing large, irregular nodules of lime. Spores globose, violaceous.

A genus readily distinguished by its laterally compressed plasmodiocarp, splitting lengthwise by a regular fissure. The wall is a single membrane, and there is but a single reticulate layer of lime upon it, which is plainly on the inner surface.

1. ANGIORIDIUM SINUOSUM Bull. Plasmodiocarp laterally compressed and very much flattened, more or less elongated and flexuous, sometimes confluent and branched or reticulate, without any hypothallus; the wall a more or less thickened and brownish membrane, the inner surface coated with a dense reticulately thickened white layer of lime, and often studded with the white nodules. Capillitium of hyaline tubules, forming a loose irregular net-work, with numerous broad vesicular expansions filled with lime; the nodules white, very large, irregularly lobed, and branched. Spores globose, very minutely warted, violaceous, 8–10 mic. in diameter.

Growing on old leaves, sticks, mosses, etc. Plasmodiocarp commonly about 1 mm. in height and 1–5 mm. in length, but the size is variable. The color appears to depend upon the thickening of the membrane; when it is thin and pellucid, the color is white or cinereous from the inner layer of lime and the contained spores; with a more thickened membrane, the color becomes ochraceous or brownish. *Physarum bivalve* Pers. *Physarum sinuosum* of Rostafinski's monograph.

II. CIENKOWSKIA Rost. Plasmodiocarp terete, elongated, flexuous, creeping, and reticulate, irregularly dehiscent; the wall a more or less thickened membrane, externally naked, with the granules of lime on the inner surface. Capillitium

of slender tubules, combined into an irregular network, attached on all sides to the wall of the sporangium, and bearing everywhere short pointed or uncinate free branchlets; the lime in thin transverse plates and irregular nodules. Spores globose, violaceous.

The peculiar characteristic of this genus is the short free hooked and pointed branchlets of the capillitium.

1. CIENKOWSKIA RETICULATA A. & S. Plasmodiocarp more or less elongated, curved and flexuous, simple or branched, sometimes confluent and reticulate, breaking away first along the upper surface, leaving an irregular margin. The wall a firm yellow membrane, with thinner hyaline areas and with thicker yellow-brown or red-brown spots; the outer surface without any lime, smooth, and shining; the inner surface with a dense layer of yellow granules raised at intervals into transverse ridges, these are connected with broad thin flat plates of lime which traverse the capillitium, forming imperfect septa to the sporangium. Capillitium consisting of slender yellow tubules, forming a network of irregular meshes, with slight expansions at the angles and bearing along the sides short pointed or uncinate free branchlets; the tubules containing a few scattered yellow nodules of lime various in size and shape. Spores globose, very minutely warted, violaceous, 8–10 mic. in diameter.

Growing on old wood, bark, leaves, etc. Plasmodiocarp in veins .3–.5 mm. in thickness, sometimes forming a net-work a centimeter or more in extent. This curious Myxomyces seems very rare in America. I have met with it but once. The specimen in the herbarium of Schweinitz, marked *Physarum reticulatum*, is not this species, though it answers well enough to the original description.

III. LEOCARPUS Link. Sporangia subglobose or obovoid, stipitate or sessile; the wall a more or less thickened membrane, the external surface destitute of lime, polished and shining, irregularly dehiscent. Stipe short, poorly developed or sometimes wanting. Capillitium of slender tubules, forming an irregular net-work more or less expanded at the angles;

the tubules enlarging at intervals into vesicles, which usually contain nodules of lime. Spores globose, violaceous.

A genus characterized by the form of the sporangia and the smooth and glossy surface of the wall.

1. LEOCARPUS PSITTACINUS Ditm. Sporangium small globose or somewhat depressed, stipitate or subsessile; the wall a thin membrane, rugulose and iridescent, with thicker red or yellow spots and patches, destitute of lime. Stipe weak, erect or inclined, variable in length, the base expanded, orange to red in color. Capillitium a dense net-work of tubules, widely expanded at the angles and bearing numerous irregular vesicles, various in size and form, yellow or orange to red in color. Spores globose, even, dark violaceous, 7–9 mic. in diameter.

Growing on old wood, leaves, etc. The sporangium .5–.6 mm. in diameter, the stipe about the same length or sometimes very short. The sporangia are dull brownish to the naked eye, but when magnified the green, purple, and blue metallic tints of the wall become apparent. There does not appear to be any granules of lime either on the wall or in the capillitium. *Physarum psittacinum* Ditm.

2. LEOCARPUS CÆSPITOSUS Schw. Sporangium small subglobose or obovoid to turbinate, somewhat irregular, stipitate or subsessile; the wall a reticulately thickened and fragile membrane, yellow-brown to greenish-yellow or olivaceous in color, externally rugulose and glossy, the inner surface with scales and patches of lime. Stipe short and thick, sometimes nearly obsolete, yellowish or reddish brown, darker below, the base expanded into a small hypothallus. Capillitium a loose irregular net-work of tubules with wide expansions at the angles; the nodules of lime large, numerous, white or yellowish, irregular, with acute angles and pointed lobes. Spores globose, minutely warted, dark violaceous, 9–11 mic. in diameter.

Growing cæspitosely or scattered on old wood and mosses. Sporangium .6–.8 mm. in diameter, variable in shape, the stipe usually very short. *Physarum cæspitosum* Schw., *North American Fungi.* My specimens, some of them, have been referred to *Physarum citrinellum* Peck; others to *Physarum variabile* Rex.

3. LEOCARPUS BRUNNEOLUS Phillips. Sporangium large, globose or somewhat depressed, sessile; the wall a thick yellow-brown membrane, the outer surface naked, smooth, and polished, with a dense white inner layer of granules of lime, dehiscing in a stellate manner, the segments becoming reflexed. Capillitium of tubules forming a dense net-work, with wide expansions at the angles; the nodules of lime very large, numerous, white, angular and irregular. Spores globose, minutely warted, dark violaceous, 8–10 mic. in diameter.

Growing on bark of oak, California (*Harkness.*) Sporangium nearly 1 mm. in diameter. *Diderma brunneolum* Phillips. I have taken the description from Massee's monograph.

4. LEOCARPUS FRAGILIS Dicks. Sporangium very large, obovoid-oblong, stipitate or subsessile; the wall a greatly thickened membrane, polished and shining within and without, from alutaceous or pale umber to dark-brown in color, destitute of lime. Stipe short, weak, and slender, arising from a thin hypothallus. Capillitium of slender tubules forming a loose network of large irregular meshes, with slight expansions at the angles; the lime white, variable in amount, sometimes quite scanty, then again filling large portions of the net-work with long-branched and reticulate masses. Spores subglobose, dark violaceous, opaque, 12–15 mic. in diameter.

Growing gregariously on old wood, leaves, mosses, etc. Sporangium 1.5–2 mm. in length by 1 mm. in thickness, the stipe variable in length, but usually much shorter than the sporangium. *Diderma vernicosum* Pers.

IV. PHYSARELLA Peck. Sporangium oblong, stipitate; the apex re-entrant and confluent with the hollow columella; the wall a thin membrane covered with small scales and minute granules of lime, at maturity torn away at the apex and stellately splitting into a few segments. Stipe elongated, tapering upward, entering the sporangium and prolonged to the apex as a tubaeform columella. Capillitium distinguished by two distinct sets of tubules; the first consisting of long, thick tubules filled with lime, rising at regular intervals from

the wall of the sporangium and extending to the columella; the second, of very slender threads, scarcely branched, and nearly destitute of lime, stretching between the wall and the columella. Spores globose, violaceous.

A genus founded upon the one remarkable species, and more distinct than any other from the typical genus of the Physaraceae. In fact, the structure of the sporangium is unique among the Myxomycetes.

1. PHYSARELLA OBLONGA B. & C. Sporangium oblong, the apex re-entrant and confluent with the summit of the columella, the base obtuse or slightly umbilicate, stipitate, cernuous. The wall of the sporangium a firm, yellowish membrane, covered with minute granules and with scattered, small, yellow scales of lime; after maturity the apex is torn away more or less irregularly from the summit of the columella and the wall splits into a few segments, which become reflexed and are subpersistent about the base of the sporangium. Stipe long, erect or flexuous, the apex bent or curved, red-brown, rising from a small hypothallus, entering the sporangium and prolonged to the apex as a hollow tubaeform columella. Capillitium of thick, spiniform tubules filled with lime and slender, violet threads, extending between the wall and the columella. The tubules elongated, terete, tapering gradually from wall to columella, containing yellow granules of lime; the threads very slender, outwardly branched a time or two, the further extremities connected by short, lateral branches, often furnished with minute, free branchlets, and containing a few small, fusiform nodules of lime. Spores globose, nearly smooth, violaceous, 7–9 mic. in diameter.

Growing on old wood, bark, leaves, etc. Sporangium commonly .8–1.0 mm. in length by .5–.6 mm. in diameter, the stipe 1–2 mm. long; the spiniform tubules measure 150–200 x 15–20 mic.

The abnormal forms of this species which sometimes manifest themselves are very singular; the sporangium has a tendency to dilate, becoming funnel-form or even salver-shaped, the stipe shortening and even disappearing. I have a large specimen which superficially resembles some lichen, a *Physcia*, for example; the sporangia are pressed down, flattened out, extremely irregular, and in many places confluent;

the rudimentary stipes are hidden beneath the leafy expansions. In all the forms, however, may be uncovered the spiniform tubules mingled with the slender threads. This is *Trichamphora oblonga* B. & C. *Tilmadoche oblonga* of Rostafinski's monograph, and *Physarella mirabilis* Peck.

V. CYTIDIUM Morgan. Gen. nov. Sporangium globose or rarely ellipsoidal, stipitate; the wall a thin membrane, with an external layer of minute granules of lime, rupturing irregularly. Stipe more or less elongated, tapering upward and entering the sporangium as a columella. Capillitium of slender tubules, arising from the columella, repeatedly branching and anastomosing to form a regular net-work, the extremities attached on all sides to the wall of the sporangium, the tubules containing at intervals nodules of lime. Spores globose, violaceous.

This genus is readily distinguished from *Physarum* by the columella, which gives origin to the capillitium; this feature indicates a relationship to *Didymium* and to *Lamproderma*.

§1. EUCYTIS. Sporangium globose, the columella not reaching its center.

1. CYTIDIUM PULCHERRIMUM B. & R. Sporangium globose, stipitate; the wall a thin lilac-tinted membrane, with a dense closely adherent layer of granules of lime, dark purple or wine-colored. Stipe long, erect, dark purple to purplish black, tapering upward and entering the sporangium as a slight obtuse columella. Capillitium of slender lilac tinted threads, forming a dense net-work of very small meshes, with slight expansion at the angles; the nodules of lime very small, numerous, dark purplish or vinose in color, ellipsoidal or obtusely angular. Spores globose, even, lilac, 7–9 mic. in diameter.

Growing on old wood. Sporangium .4–.5 mm. in diameter, the stipe two or three times as long; the lime-nodules about the size of the spores. The purple stain, which the sporangia leave on white paper, is made by the granules of lime; the

spores color the paper violet. *Physarum pulcherrimum* B. & Rav., and *P. atrorubrum* Peck.

2. CYTIDIUM CITRINUM Schum. Sporangium globose, the base slightly flattened or umbilicate, stipitate; the wall a thin membrane, covered with small scales of lime, yellow or greenish-yellow, breaking up and falling away at maturity. Stipe stout, erect, yellow, longitudinally rugulose, expanded at the base, tapering upward and entering the sporangium as a short obtusely conical columella. Capillitium of slender tubules, forming a dense net-work, with slight expansions at the angles; the lime-nodules numerous, roundish or ellipsoidal, variable in size, yellow. Spores globose, nearly smooth, violaceous, 7–8 mic. in diameter.

Growing on bark, leaves, mosses, etc. Sporangium .5–.6 mm. in diameter, the stipe from once to twice this length. This, the typical species, I have not seen in this country, but forms with the sporangium lemon-yellow and grayish-yellow, with the stipe golden-yellow, connect it with *C. rufipes*. It is *Physarum citrinum* Schum. *Diderma citrinum* of Fries., S. M.

3. CYTIDIUM RUFIPES A. & S. Sporangium globose, sometimes a little depressed and the base umbilicate, stipitate; the wall a thin membrane, covered with small scales of lime, golden-yellow to orange in color, breaking up at maturity and falling away. Stipe variable in length, slender, from orange or orange-red to dark red in color, sometimes blackish below, rising from a thin hypothallus, tapering upward and entering the sporangium as a short obtuse columella. Capillitium of slender tubules, forming a dense net-work of very small meshes, slightly expanded at the angles; the nodules of lime small, numerous, ellipsoidal or obtusely angular, orange to red in color. Spores globose, nearly smooth, violaceous, 8–10 mic. in diameter.

Growing on old wood, mosses, etc. A very abundant species. Sporangium .5–.7 mm. in diameter, the stipe from once to twice as long. As here defined, the species includes *Physarum aurantium* var. *rufipes* A. & S., and *Physarum aureum* var. *chrysopus* Lev, which I am unable to keep separate; the variation in size of the spores is not in correspondence with the variations in color of the sporangia. *Physarum*

pulchripes Peck, and *Physarum petersii* B. & C., mostly belong here. The bright orange colors become dull or tawny with age and exposure to the weather.

4. CYTIDIUM RAVENELII B. & C. Sporangium globose, stipitate; the wall a thin pellucid membrane, covered with small scales of lime, from gray or drab to pale umber in color, breaking up at maturity and falling away. Stipe variable in length, concolorous with the sporangium or darker below, tapering upward and entering the sporangium as a short obtusely conical columella. Capillitium of tubules, forming a dense net-work of very small meshes, with slight expansions at the angles; the lime-nodules small, numerous, ellipsoidal or obtusely angular, gray or drab to pale umber in color. Spores globose, nearly even, pale violaceous, 7–9 mic. in diameter.

Growing on old wood, mosses, etc. Sporangium about .5 mm. in diameter, the stipe once to twice this length. The species as here described includes *Didymium ravenelii* B. & C., *Physarum simile* Rost., and *Physarum murinum* Lister.

5. CYTIDIUM GLOBULIFERUM Bull. Sporangium globose, the base sometimes flattened or slightly umbilicate, stipitate; the wall a thin, pellucid membrane, covered with small scales of lime, white, cream-colored, or sometimes pinkish, breaking up and falling away at maturity. Stipe variable in length, white or smoky-white, usually darker below, rising from a thin hypothallus, tapering upward and entering the sporangium as a short obtuse or conical columella. Capillitium of slender tubules, forming a dense, persistent net-work of very small meshes, more or less expanded at the angles; the nodules of lime variable in size, numerous, white, roundish, ellipsoidal or obtusely angular. Spores globose, nearly even, pale violaceous, 7–9 mic. in diameter.

Growing on old wood, bark, mosses, etc. A very common and abundant species. Sporangium .5–.6 mm. in diameter, the stipe from once to two or three times this length. The lime nodules in the capillitium are sometimes round and quite minute, then again they are large and obtusely angular; the columella varies from very short and conical to longer and more cylindric. *Diderma globuliferum* of Fries S. M.,

Physarum albicans Peck. The specimens with the columella well nigh obsolete, may be *Tilmadoche columbina* Rost.

6. CYTIDIUM MELLEUM B. & Br. Sporangium globose, stipitate or subsessile; the wall a thin yellowish membrane, rugulose, covered by large irregular scales of lime, honey-color to golden-yellow, breaking up irregularly. Stipe short, sometimes very short or nearly obsolete, snow-white, expanding at the base into a small white hypothallus, tapering upward and entering the sporangium as a short obtusely conical columella. Capillitium a loose net-work of delicate tubules with broad vesicular expansions containing much lime; the nodules numerous, white or sometimes yellow, large, irregular, lobed, and branched. Spores globose, nearly even, pale violaceous, 7–9 mic. in diameter.

Growing on old leaves, sticks, herbaceous stems, etc.; not uncommon in this region. Sporangium .4–.5 mm. in diameter, the stipe about the same length or much shorter. *Didymium melleum* B. & Br. *Didymium chrysopeplum* B. & C. also belongs here and not with *C. citrinum.*

§2. REXIELLA. Sporangium ellipsoidal or pyriform, the columella prolonged nearly to the apex of the sporangium.

7. CYTIDIUM PENETRALE Rex. Sporangium ellipsoidal or pyriform, stipitate; the wall a thin pellucid membrane, covered with small scales of lime, yellow-gray to greenish-yellow, rupturing at maturity into two to four segments. Stipe long, slender, translucent, pale red to dark red in color, tapering upward, entering the sporangium and prolonged nearly to the apex as a slender columella. Capillitium of very slender tubules, radiating from numerous points of the columella, forming a delicate net-work of very small meshes, scarcely expanded at the angles; the nodules of lime small, not numerous, roundish or obtusely angled, white or yellowish. Spores globose, very minutely warted, pale violaceous, 5.5–6.5 mic. in diameter.

Growing on old wood. A rare and singular species. Sporangium .5–.7 mm. in height by .3–.5 mm. in diameter, the stipe two or three times the height of the sporangium. There is an affinity between this species and the *Physarella*. The obscure *Tilmadoche hians* Rost., may be the same as the present species.

VI. CRATERIUM Trent. Sporangium obovoid to cylindric, stipitate; the upper and usually greater part of the wall covered with granules of lime, the basal portion naked and more persistent. Stipe short or sometimes elongated, arising from a small circular hypothallus, longitudinally plicate, confluent above and similarly colored with the base of the sporangium. Capillitium of tubules, forming a loose network, bearing numerous large angular and irregular nodules of lime, which are often confluent along the axis of the sporangium into a pseudo-columella. Spores globose, minutely warted, violaceous.

In this genus the sporangium is commonly obovoid, with a naked base which is confluent with the stipe and similarly colored; after dehiscence there is left behind the more persistent cyathiform portion standing on the substratum.

§1. EU-CRATERIUM. Sporangium at maturity dehiscent in a regular circumcissile manner, the apex falling away as a lid, leaving behind the more persistent cup-shaped portion.

1. CRATERIUM MINUTUM Leers. Sporangium cyathiform, stipitate; the lid slightly convex, discrete from the first, usually depressed below the rim of the cup, falling away at maturity, and leaving a smooth, circular margin to the lower cyathiform portion. The wall a thick, firm, yellow-brown membrane, the outer surface of the cup entirely naked, smooth and shining, varying greatly in color from alutaceous or ochraceous to various shades of brown; the lid usually whitened by a thin layer of granules of lime. Stipe short, erect or bent, and slightly curved at the apex, varying in color from rusty yellow to reddish brown, longitudinally plicate, arising from a small, circular hypothallus. Capillitium of tubules forming a loose net-work, bearing large, irregular, white nodules of lime, which are sometimes confluent in the axis of the sporangium. Spores globose, very minutely warted, violaceous, 8–10 mic. in diameter.

Growing on old wood, sticks, leaves, etc. Sporangium, together with the stipe, .8–1.4 mm. in height and .3–.5 mm. in diameter, the stipe usually shorter than the sporangium, sometimes equal to it in length, rarely longer. The latest authorities include the three species *Craterium vulgare*, *C.*

pyriforme, and *C. minutum* of Rostafinski's monograph all in one species.

2. Craterium concinnum Rex. Sporangium usually minute, broadly funnel-shaped, stipitate; operculum always more or less convex, rarely approaching a hemispherical shape, dehiscent in a regular circumscissile manner. The wall a thick, brownish membrane, externally smooth and variously colored, sometimes uniformly light or dark umber, sometimes dark brown below and brownish white above; the operculum brownish white, darkest in the center. Stipe short, dark brown, longitudinally ridged. Capillitium of tubules forming a close-meshed net-work, bearing small rounded or slightly angular nodules of lime, ochre-brown in color. Spores globose, very minutely warted, brown, 9–10 mic. in diameter.

Growing usually upon chestnut-burs, and frequently associated with *Lachnobulus globosus*. Sporangium .5–.8 mm. in height including the stipe and .2–.5 mm. in diameter at the top, the stipe equaling the sporangium in length. It is readily distinguished by its small nodules in the capillitium, which are invariably of a dull, brownish-ochre color.

3. Craterium rubescens Rex. Sporangium subcylindric or elongated cyathiform, stipitate; the apex convex, at maturity separating by an irregular line in a circumcissile manner. The wall dark violet-red, smooth, except at the upper portion, which is slightly roughened by an external deposit of scattered lime-granules of a pale, lilac color. Stipe short, violet-black, wrinkled longitudinally. Capillitium of tubules forming a loose, irregular net-work, bearing large, violet-red nodules of lime which are often confluent in the axis of the sporangium. Spores globose, minutely warted, dark violaceous, 7–9 mic. in diameter.

Growing on old wood, leaves, etc. Sporangium .6–.8 mm. in height including the stipe and .5–.6 mm. in diameter, the stipe one-half the height of the sporangium. The species is distinguished by the color, which exhibits some shade of red or violet-red in every part of its structure.

4. Craterium minimum B. & C. Sporangium cylindric or turbinate-cylindric, stipitate; the apex convex, separating in a regular circumcissile manner by a lid. The wall a thick,

yellow-brown membrane, most of the outer surface covered with minute, white granules of lime, the basal portion naked. Stipe very short, plicate, red-brown, arising from a small hypothallus. Capillitium of tubules forming a loose net-work bearing large, irregular, white nodules of lime, sometimes confluent in the axis of the sporangium. Spores globose, very minutely warted, violaceous, 7–9 mic. in diameter.

Growing on old leaves, herbaceous stems, etc. Sporangium together with the stipe 1–1.5 mm. in height and .25–.35 mm. in thickness, the stipe .2–.4 mm. in length. This is a common species everywhere in the United States, and perfectly distinct from *Craterium convivale.* It is *Craterium cylindricum* of Massee's monograph, according to Lister.

§2. CUPULARIA, Link. Sporangium irregularly dehiscent, breaking up and gradually falling away from the apex downward.

a. Stipe shorter than the sporangium.

5. CRATERIUM CONVIVALE Batsch. Sporangium obovoid or oblong-obovoid, stipitate; the wall hyaline, thin and fragile above, the lower portion a thickened and brownish membrane, the surface, usually most of it, covered with minute white granules of lime, the base naked and brown. Stipe very short, erect, red-brown, plicate, arising from a small hypothallus. Capillitium of tubules forming a dense net-work, bearing numerous large irregular white nodules of lime, which are often confluent in the axis of the sporangium. Spores globose, very minutely warted, violaceous, 8–10 mic. in diameter.

Growing on old leaves, herbaceous stems, etc. Sporangium .6–1.0 mm. in height including the stipe and .3–.5 mm. in diameter, the stipe much shorter than the sporangium. The thin apex breaks up into pieces and falls away, leaving sometimes a regular cyathiform portion, at other times the margin is broken and irregular. This is *Craterium leucocephalum* of Rostafinski's monograph. The specimens of *Physarum scyphoides* C. & B. which I have seen appear to be a small form of this species.

6. Craterium aureum Schum. Sporangium obovoid to oblong obovoid, stipitate, the wall a thin and delicate membrane above, thicker and firmer below, hyaline or yellowish, almost entirely covered by a dense layer of granules of lime, varying from lemon-yellow to orange in color. Stipe short, erect, yellow to orange, brownish toward the base, longitudinally plicate, rising from a small hypothallus. Capillitium of slender tubules, forming a dense net-work, bearing numerous rather small irregular nodules of lime, yellow or sometimes white in color, and often confluent along the axis of the sporangium. Spores globose, very minutely warted, dark violaceous, 8–10 mic. in diameter.

Growing on old leaves, sticks, herbaceous stems, etc. Sporangium and stipe .7–1.0 mm. in height and .3–.5 mm. in diameter, the stipe .2–.4 mm. long. The elongated form is the common one in this region. *Craterium mutabile* Fr.

b. Stipe longer than the sporangium.

7. Craterium nodulosum C. & B. Sporangium globose or obovoid, stipitate; the greater part of the wall a thin hyaline membrane, easily breaking away, covered externally with large white scales and nodules of lime; the basal portion naked, thickened, and more persistent, red-brown and plicate. Stipe long, erect or inclined, plicate, red-brown, rising from a small hypothallus. Capillitium of tubules forming a loose net-work, containing a variable quantity of lime in the shape of long irregular white nodules, sometimes confluent, with pointed lobes and branchlets. Spores globose, very minutely warted, dark violaceous, 10–12 mic. in diameter.

Growing on old wood, bark, leaves, etc. Sporangium .5–.6 mm. in diameter, the stipe two or three times as long. It is *Badhamia nodulosa* C. & B., *Journal of Mycology*, Vol. V, p. 186. Ravenel's specimens are on *Acacia* bark. Mr. Webber sent me elegant specimens from Florida where, he says, it grows commonly on the leaves and bark of the orange trees.

8. Craterium maydis Morgan, n. sp. Sporangium globose or obovoid, stipitate; the upper part of the wall a yellowish membrane, thin and fragile, covered with large thick scales and nodules of lime, amber-colored to golden-

yellow; the basal portion thicker and more persistent, naked and plicate, red-brown. Stipe red-brown, long, slender, plicate, rising from a small hypothallus. Capillitium of thick tubules, forming a net-work with wide expansions at the angles; the nodules of lime large, numerous, yellow, angularly lobed and branched. Spores globose, very minutely warted, pale violaceous, 9–10 mic. in diameter.

Growing on old stalks of *Zea mays*. Sporangium with the stipe 1–1.5 mm. in height and .4–.6 mm. in diameter, the stipe always longer than the sporangium. I find it in abundance on old stalks of Indian corn, but never on anything else.

VII. PHYSARUM Pers. Sporangium globose, depressed globose or irregular, stipitate or sessile; the wall a thin membrane, with an outer layer of minute roundish granules of lime, irregularly dehiscent. Stipe present or often wanting, never prolonged within the sporangium as a columella. Capillitium of slender tubules, forming an intricate net-work, the extremities attached on all sides to the wall of the sporangium; the tubules more or less expanded at the angles of the net-work, and containing at varying intervals nodules of lime. Spores globose, violaceous.

Physarum is the central genus of the *Physaraceæ* from which all the others are detached by characters which for the most part are unimportant.

§1. LAPIDIUM. Lime in the capillitium scanty; the nodules small, roundish, ellipsoidal or fusiform.

A. Sporangium stipitate.

a. Sporangia regular.

1. PHYSARUM NUTANS Pers. Sporangium orbicular, very much depressed, the base concave or umbilicate, stipitate, cernuous; the wall a thin pellucid membrane, thickly covered with minute white or yellow roundish scales of lime, breaking up into irregular fragments, which often remain attached to the capillitium. Stipe long, slender, tapering upward,

bent or curved at the apex, longitudinally rugulose, brown or blackish at the base, becoming paler upward and cinereous or whitish at the apex. Capillitium of very slender threads, rising from the base of the sporangium, forming a net-work with much elongated meshes, scarcely expanded at the angles; the nodules of lime white or yellow, ellipsoidal or fusiform, often very small and few in number, sometimes rather large and numerous. Spores globose, very minutely warted, violaceous, 8–10 mic. in diameter.

Growing on wood, bark, mosses, etc. A very common species. Sporangium .4–.5 mm. in diameter, the stipe 1–2 mm. in length, the lime-nodules commonly not thicker than the spores, but sometimes from once to twice their diameter. Under this name I have included all the lenticular species of Persoon's Synopsis, *Physarum nutans*, *P. luteum*, *P. viride* and *P. aureum*. There is no difference in these species, except in the color of the granules of lime; the form of the sporangium and the shape and color of the stipe are the same in all of them. No two authorities agree in the presentation of this species.

2. PHYSARUM CUPRIPES B. & R. Sporangium orbicular, much depressed, the base umbilicate, stipitate, cernuous; the greater part of the wall thin and delicate, with a scanty covering of yellow granules of lime, becoming naked and then brassy and iridescent, after maturity soon disappearing; the lower basal portion thicker and more persistent, with a layer of small yellow scales of lime. Stipe long, flexuous, bent at the apex, plicate, pale brown to yellow-brown, darker toward the base. Capillitium of slender tubules, forming a dense persistent net-work, more or less expanded at the angles; the lime-nodules small, numerous, yellow, angular and fusiform, below often confluent. Spores globose, very minutely warted, violaceous, 8–10 mic. in diameter.

Growing on old wood; rare. Sporangium .4–.5 mm. in diameter, the stipe two or three times this length. The lime nodules are found both on the sides and at the angles of the meshes, and are fusiform or angular accordingly; the lime is scanty above, but in the lower part of the capillitium the nodules sometimes run together into lobed and branched forms. This is *Physarum berkeleyi* of Rostafinski's monograph.

3. PHYSARUM OBRUSSEUM, B. & C. Sporangium globose, the base usually slightly flattened or umbilicate, stipitate and cernuous; the wall a thin, violaceous membrane, covered by small, roundish, white or yellow scales of lime, or sometimes naked, splitting irregularly from the apex downward. Stipe long, slender, tapering upward, flexuous, bent or curved at the apex, yellow, yellow-brown, or pale brown. Capillitium of very slender tubules, forming a loose net-work, scarcely expanded at the angles; the nodules of lime small, white or yellow, roundish or obtusely angular, few to numerous, rarely wanting. Spores globose, very minutely warted, violaceous, 8–10 mic. in diameter.

Growing on old wood, bark, mosses, etc. Sporangium .2–.4 mm. in diameter, the stipe 1–2 mm. in length, the lime nodules when abundant once to twice the diameter of the spores, when scanty very small. This, as I find it growing, is an extremely variable species; I think its various forms and appearances cover such species as *Didymium obrusseum* B. & C.; *D. tenerrimum* B. & C.; *Physarum tenerum* Rex, etc., etc.

4. PHYSARUM NUCLEATUM Rex. Sporangium globose, stipitate, erect or slightly nodding; the wall a thin, pellucid membrane, thickly covered with minute, white, roundish scales of lime, which are exceptionally sparse or absent, rupturing irregularly. Stipe long, slender, yellowish-white, longitudinally rugulose, tapering upward, expanded at the base into a small hypothallus. Capillitium of very slender tubules, forming a delicate net-work of small meshes, scarcely expanded at the angles; nodules of lime small, not numerous, roundish, white, usually concentrated into a large lump in the center of the sporangium. Spores globose, very minutely warted, violaceous, 6–7 mic. in diameter.

Growing on old wood, bark, etc.; rare. Sporangium .4–.5 mm. in diameter, the stipe two or three times as long, the lime-nodules about the size of the spores. The species much resembles some of the forms of *P. obrusseum*, but is to be distinguished by its central mass of lime and the small spores.

5. PHYSARUM COMPACTUM Wingate. Sporangium depressed-globose, the base slightly umbilicate, stipitate, cernu-

ous; the wall a thin, violaceous membrane, rugulose and iridescent, studded with large and thick, snow-white, roundish or elliptic scales of lime, at maturity splitting from the apex downward into several segments. Stipe long, rather weak, bent and flexuous, tapering upward, longitudinally rugulose, from snow-white to whitish-ochre and smoky-white, usually brownish at the base, and arising from a thin hypothallus. Capillitium a delicate net-work of very slender threads, with no expansions at the angles; the lime mostly concentrated in one large, snow-white nodule at the center, a few very small, roundish nodules scattered through the net-work. Spores globose, very minutely warted, violaceous, 7–9 mic. in diameter.

Growing on old wood, mosses, etc.; a common species. Sporangium .4–.5 mm. in diameter, the stipe two or three times this length. *Tilmadoche compacta* Wingate. It is doubtful if *Tilmadoche columbina* Rost. belongs to this species. According to Lister, *Lepidoderma stellatum* Massee, is the same as this species, and if it be objected to the name that there is already a *Physarum compactum* Ehrenberg, it may have to be called *Physarum stellatum.*

b. Sporangium more or less irregular.

6. Physarum leucophæum Fr. Sporangium globose or depressed-globose, more or less irregular, the base never umbilicate, stipitate or subsessile; the wall a thin violaceous membrane, rugulose and iridescent, with a thin coat of small white scales and granules of lime, or sometimes nearly naked. Stipe variable in length, sometimes very short or quite obsolete, occasionally a few of them confluent, wrinkled, and sulcate, brown below, paler or whitish above. Capillitium a dense irregular net-work of slender tubules, more or less expanded at the angles; the nodules of lime white, small, roundish, or angular, few and scattered. Spores globose, very minutely warted, violaceous, 8–10 mic. in diameter.

Growing on old wood, bark, leaves, etc. The sporangium .5–.7 mm. in diameter, the stipe about the same length, or shorter, and sometimes wanting. The lime on the wall and in the capillitium is never abundant and sometimes extremely

scanty. Rostafinski's presentation of this species applies well to our specimens.

7. PHYSARUM CONNEXUM Link. Sporangia subglobose, depressed, more or less irregular, sometimes confluent, stipitate, or subsessile; the wall a thin violaceous, or brownish membrane, rugulose, thickly covered with small white roundish scales of lime, which sometimes accumulate so as to make the surface rough and uneven. Stipe short, thick, rugulose, from snow-white to smoky or sooty, especially toward the base, sometimes with a scanty calcareous hypothallus. Capillitium a loose net-work of tubules, much expanded at the angles; the nodules of lime small, white, rather numerous, ellipsoidal or fusiform, sometimes confluent and elongated. Spores irregularly globose, minutely warted, dark violaceous, 9–11 mic. in diameter.

Growing on old wood and bark. Sporangium .6–1.0 mm. in diameter, the stipe usually shorter than the diameter, sometimes very short; the lime-nodules about the thickness of the spores. This is a larger and rougher species than *P. leucophæum*, the sporangium is more often irregular and the spores darker colored. *P. confluens* and *P. connexum* of Link.

8. PHYSARUM COMPRESSUM A. & S. Sporangium laterally compressed and much flattened, subreniform, stipitate or subsessile; the wall a thin violaceous or brownish membrane, rugulose, thickly covered with small white roundish nodules of lime, similar to those in the capillitium. Stipe short, brown or blackish at least below, sometimes pallid or grayish above, longitudinally rugulose. Capillitium of slender tubules, forming a loose net-work; the nodules of lime small, white, very numerous, roundish or ellipsoidal, often confluent end to end. Spores irregularly globose or angular, minutely warted, dark violaceous, 11–14 mic. in diameter.

Growing on old stalks and leaves of *Zea mays*. Sporangium variable, .6–1.0 mm. in breadth, the stipe 1 mm. or less in length; the lime-nodules about the thickness of the spores. According to Saccardo this species is the same as *Physarum nephroedium* Rost.

9. PHYSARUM POLYCEPHALUM Schw. Sporangia confluent into a subspheric gyrose-complicate head, composed of

several to many laterally compressed, irregular, simple sporangia; the wall a thin, pellucid membrane, covered by a thin layer of minute scales of lime, white to yellow or greenish-yellow. Stipes thin, flat, weak, and often prostrate, pale yellow, more or less connate, arising from a thin hypothallus. Capillitium of slender tubules forming a loose, irregular net-work, more or less expanded at the angles: the lime-nodules white or yellow, small, fusiform or by confluence elongated and sometimes branched. Spores globose, very minutely warted, violaceous, 8–10 mic. in diameter.

Growing on old bark, wood, leaves, etc. The sporangia rarely simple, usually confluent into a head of from four or five to fifteen or twenty, and sometimes more, simple sporangia; the stipes variable in length, long or short, rarely wanting. The gray form is *Didymium polymorphum* Mont., the yellow-green form *D. gyrocephalum* Mont. Sprengel considered this species the same as *Physarum compactum* Ehr., and it appears under this name in Schweinitz's *North American Fungi*; but Fries, who had seen specimens of both, disposed of them differently.

10. PHYSARUM DIDERMOIDES Pers. Sporangia obovoid-oblong, stipitate, growing close together on a white membranaceous common hypothallus; the wall with a thick, white, outer layer of lime, easily crumbling and falling away, leaving the sporangium dark gray; the inner membrane rather thick and firm, violaceous, with a closely adherent layer of granules of lime. Stipes very short, white, thin, and weak, each formed by a bit of membrane arising from the hypothallus. Capillitium a loose net-work of slender threads, bearing numerous roundish or irregular white nodules of lime. Spores irregularly or angularly globose, minutely warted, dark violaceous, 12–15 mic. in diameter.

Growing on wood, leaves, grass, etc. Sporangia .6–1.2 mm. in length by .4–.6 mm. in thickness, the stipe shorter than the sporangia. *Spumaria licheniformis* Schw., belongs here. This is a truly abnormal species of *Physarum*, so much so that Fries, in the *Summa Veg. Scand.* placed it by itself in a separate genus, *Claustria*.

B. Sporangia sessile.

11. PHYSARUM CONFLUENS Pers. Plasmodiocarp roundish, oblong or elongated, and by confluence branched and reticulate; the wall a thin, violaceous membrane, rugulose, with a thin, closely adherent layer of minute granules of lime, over which are scattered small, white, roundish nodules, which sometimes accumulate into a thick, pulverulent coat. Capillitium a loose net-work of tubules, widely expanded at the angles; the nodules of lime small, white, very numerous, roundish or ellipsoidal, by confluence elongated and irregular. Spores irregularly globose, minutely warted, dark violaceous, 9-11 mic. in diameter.

Growing on old wood, bark, leaves, etc. Plasmodiocarp .4-.5 mm. in thickness, varying from roundish to much elongated, creeping and reticulate. The sporangium before dehiscence is gray, whence Link's name, *Physarum griseum;* the loose pulverulent coating of lime easily falls away, leaving the sporangium dark colored, whence Rostafinski's name, *Physarum lividum.* The amount of lime on the wall and in the capillitium is variable.

12. PHYSARUM LUTEOLUM Peck. Sporangia small, subglobose, sessile, closely gregarious; the wall a thin membrane, covered by a layer of small scales of lime, yellowish, inclining to tawny, in color, rupturing irregularly. Capillitium of slender tubules, forming a dense net-work of small meshes, scarcely expanded at the angles; the nodules of lime small, numerous, yellowish, roundish, or ellipsoidal. Spores globose, nearly smooth, violaceous, about 10 mic. in diameter.

Growing on living leaves of *Cornus canadensis,* Adirondack Mountains, New York. I have not seen a specimen of this *Physarum,* but from Professor Peck's description and figure it seems to be a unique species.

13. PHYSARUM THEJOTEUM Fr. Sporangia very small, sessile, on a thin membranaceous hypothallus, closely crowded together and more or less connate, subobovoid or oblong, irregular from mutual pressure; the wall a thin violaceous membrane, closely covered with a thin layer of small irregular scales of lime, tawny or yellowish tawny in color, breaking up irregularly about the apex. Capillitium a loose irregu-

lar net-work of slender threads, more or less expanded at the angles; the lime nodules small, tawny or yellowish, not numerous, ellipsoidal or fusiform, by confluence elongated and irregular. Spores globose, even, violaceous, 6–7 mic. in diameter.

Growing on old wood, mosses, etc. Sporangia .2–.4 mm. in diameter at the apex, densely packed and their walls grown together, approaching the aethalioid structure; the lime-nodules from one to two or three times the diameter of the spores in thickness. I have described my specimens, which are abundant, very carefully, and judge them to be referable to this species; if so, they show that the species should be kept apart from *Physarum virescens*. *Didymium nectriæforme* B. & C., is evidently this same species.

14. PHYSARUM LATERITIUM B. & R. Sporangia sessile, irregularly globose and gregarious, or by confluence more or less elongated and plasmodiocarp; the wall a thin violaceous membrane, rugulose and iridescent, closely covered with small irregular scales of lime, from testaceous or brick-red to bright red in color. Capillitium a dense irregular net-work of tubules, much expanded at the angles; the nodules of lime small, very numerous, roundish or angular, whitish or yellowish, sometimes tinged with red granules. Spores globose, very minutely warted, violaceous, 8–10 mic. in diameter.

Growing on old wood, sticks, leaves, etc. Sporangia .4–.6 mm. in diameter, by confluence sometimes much elongated; the lime-nodules two or three times the diameter of the spores in thickness. *Didymium lateritium* B. & R. *Physarum inequale* Peck, is the same species.

§2. SAXELLA. Lime in the capillitium abundant, the nodules large, angular or irregular, with pointed lobes and branchlets.

A. Sporangia stipitate.

15. PHYSARUM IMITANS Racib. Sporangium depressed-globose, the base flattened or umbilicate, stipitate, erect or cernuous; the wall a thin violaceous membrane, with a

closely adherent layer of minute granules, over which are scattered rather large, roundish or irregular white scales of lime, splitting from the apex downward into a few irregular segments. Stipe short, thick at the base and tapering upward, longitudinally rugulose, from gray to brown or blackish, especially below. Capillitium a loose irregular net-work of tubules, widely expanded at the angles; the nodules of lime white, numerous, large, irregular, with pointed angles and lobes. Spores globose, very minutely warted, violaceous, 8–9 mic. in diameter.

Growing on old wood, mosses, etc. Sporangium .4–.5 mm. in diameter, the stipe about the same length or a little longer. The species superficially resembles the gray form of *Physarum nutans*, and quite likely is constantly overlooked on this account. Although I am not able to verify my reference, yet my specimens answer so well to the description of Raciborski that I am unwilling to invent a new name.

16. PHYSARUM ORNATUM Peck. Sporangium globose or depressed-globose, stipitate; the wall a thin yellowish membrane, covered with minute granules and small irregular scales of lime, yellow to orange in color. Stipe short, erect, blackish-brown, black at the base, longitudinally plicate, rising from a small hypothallus. Capillitium of tubules forming a rather dense net-work, with wide expansions at the angles; the nodules of lime large, numerous, yellow, irregular, sometimes confluently branched and reticulate. Spores globose, minutely warted, dark violaceous, 10–12 mic. in diameter.

Growing on old wood, bark, mosses, etc. Sporangium about .5 mm. in diameter, the stipe about the same length or shorter. *Physarum oblatum* McBride, can not be distinguished from this. Specimens of this species in the herbarium of Schweinitz are labeled *Physarum sulphureum;* this is without doubt a mistake.

17. PHYSARUM GRAVIDUM Morgan, n. sp. Sporangium depressed-globose, the base umbilicate, stipitate; the wall a thin, violaceous membrane, brownish at the base, with a thin coat of small, white scales and minute granules of lime. Stipe long, erect, brown or reddish-brown, darker below, tapering

upward, expanding at the base into a small hypothallus. Capillitium of slender tubules forming a loose net-work, more or less expanded at the angles and for the most part filled with lime; the nodules white, slender, much elongated and branched, with pointed lobes and branchlets. Spores globose, very minutely warted, dark violaceous, 11–13 mic. in diameter.

Growing on old stalks of *Zea mays*. Sporangium .5–.6 mm. in diameter, the stipe about twice this length. The lower part of the capillitium is sometimes entirely filled with lime, so that the species approaches Badhamia in the structure of its capillitium.

18. Physarum leucopus Link. Sporangium globose, the base slightly flattened, stipitate; the wall a thin, violaceous membrane, with a white, pulverulent outer coat of minute granules of lime. Stipe short, thick, erect, snow-white, longitudinally rugulose, tapering upward, expanding at the base into small, white hypothallus. Capillitium a loose net-work of tubules, with wide expansions at the angles; the nodules of lime large, white, numerous, irregularly lobed and branched. Spores globose, very minutely warted, violaceous, 8–10 mic. in diameter.

Growing on old wood, leaves, etc. Sporangium .3–.4 mm. in diameter, the stipe about the same length as the diameter. Our specimens are a smaller form than the European, with smaller and smoother spores. Superficially the species resembles *Didymium squamulosum*, and it is *Didymium leucopus* of Fries, S. M.

19. Physarum glaucum Phillips. Sporangium globose, or the base slightly depressed, stipitate; the wall a thin, violaceous membrane, covered with minute, white granules and small roundish or irregular scales of lime. Stipe short, stout, erect, black, longitudinally wrinkled, expanding at the base into a small hypothallus. Capillitium of much-flattened tubules, forming a loose net-work, widely expanded at the angles; the nodules of lime numerous, large, white, irregular, with pointed angles and lobes. Spores globose, very minutely warted, dark violaceous, 12–14 mic. in diameter.

Growing on old leaves: California. Sporangium .5–.7 mm.

in diameter, the stipe not longer than the diameter. This is quite a robust species, both externally and in the broad, flat tubules of the capillitium.

20. PHYSARUM RELATUM Morgan, n. sp. Sporangium globose, the base umbilicate, stipitate, often cernuous; the wall a thin, violaceous membrane, rugulose and iridescent, covered with small, roundish or irregular white scales of lime. Stipe long, erect or inclined, rising from a thin hypothallus, tapering upward, white or cream color to ochraceous. Capillitium a dense net-work of tubules, more or less expanded at the angles, and almost entirely filled with white granules of lime, leaving only here and there short, slender empty spaces. Spores globose, nearly smooth, violaceous, 8–9 mic. in diameter.

Growing on old wood. Sporangium .5–.6 mm. in diameter, the stipe about twice this length. The capillitium is rigid, with the abundance of lime almost as in the genus *Badhamia*. Superficially the species much resembles *Cytidium globuliferum* or *Physarum compactum*, but the disposition of the lime on the wall and in the capillitium is altogether different.

21. PHYSARUM AURISCALPIUM Cke. Sporangia subglobose, depressed, substipitate; the wall a hyaline membrane with a thin, closely adherent layer of minute granules of lime, over which are scattered large, irregular, orange-red scales of lime. Stipe very short, sometimes almost obsolete. Capillitium of tubules forming a loose net-work, with widely expanded angles, and mostly filled with orange granules of lime, only here and there short, slender, empty spaces. Spores globose, minutely warted, dark violaceous, 11–13 mic. in diameter.

Growing on rotten wood; South Carolina, Ravenel. Sporangia .6–.8 mm. in diameter, the stipe very short. Described in *Annals of the Lyceum of Natural History of New York*, June, 1877. So fine a species ought to be found again. Cooke's specimen was examined by Lister, *Mycetozoa*, p. 61.

B. Sporangia sessile.

22. PHYSARUM PLUMBEUM Fr. Sporangia small, globose or obovoid, sessile, on a narrow base, gregarious, sometimes close but seldom confluent; the wall a thin violaceous mem-

brane, with a very thin layer of small white scales and minute granules of lime, sometimes naked. Capillitium a loose net-work of slender tubules, with slight expansions at the angles; the nodules of lime white, numerous, more or less elongated, irregularly lobed and branched. Spores globose, even, violaceous, 7–9 mic. in diameter.

Growing on old leaves, sticks, etc, Sporangia .3–.4 mm. in diameter, quite regular in shape, attached by a narrow base, sometimes by a mere point, rarely confluent. The lime on the wall of the sporangium is rather scanty, sometimes altogether absent, and the nodules of lime in the capillitium are rather small. The species is figured by Micheli N. P. G. Tab. 96, Fig. 9. It is named by Fries S. M., III, p. 142. It is figured again by De Bary, *Die Mycetozoen*, Tafel I.

23. PHYSARUM ATRUM Schw. Sporangia sessile, subglobose or oblong, by confluence, more or less elongated, bent or flexuous and branched; the wall a thin violaceous membrane, rugulose, covered by a wrinkled and reticulate layer of white granules of lime, which sometimes become thin or disappear. Capillitium a loose net-work of tubules, more or less expanded at the angles; the nodules of lime white, numerous, large, irregularly lobed and branched. Spores globose, very minutely warted, violaceous, 8–10 mic. in diameter.

Growing on old leaves, bark, grasses, etc.; apparently the most common of these three cinereous species. Sporangia .3–.5 mm. in thickness, some of them roundish or oblong, others elongated to several millimeters. The sporangium is often elegantly reticulate as observed by Schweinitz even when the lime is quite scanty. In Saccardo's *Sylloge* Berlese changed the name to *Physarum reticulatum*, but this is unnecessary, as the *Physarum atrum* of Fries is not a Myxomyces.

24. PHYSARUM CINEREUM Batsch. Sporangia large, subglobose, sessile, gregarious, sometimes close and confluent; the wall a thin violaceous membrane, with a closely adherent layer of minute granules, over which are scattered irregular white scales of lime. Capillitium of tubules forming a loose net-work, with wide expansions at the angles; the nodules of lime numerous, white, very large, with pointed angles and lobes, by confluence often branched and reticulate,

and occasionally forming a pseudo-columella in the center of the sporangium. Spores globose, minutely warted, dark violaceous, 10–13 mic. in diameter.

Growing on old wood, leaves, etc. The sporangia .4–.6 mm. in diameter, more or less irregular. The great abundance of lime in the capillitium and the large distinctly warted spores distinguish this species. *Physarum cinereum* of Persoon's Synopsis, *Didymium cinereum* of Fries' *Systema*. The only American specimens I have of this species are from Iowa (*McBride*) and from Nebraska (*Webber*).

25. PHYSARUM VIRESCENS Ditm. Sporangia large, subglobose, irregular and unequal, sessile, gregarious, sometimes crowded, but not often confluent; the wall a thin membrane, violaceous, or in places yellowish, with a dense layer of yellow or greenish-yellow scales and granules of lime. Capillitium a loose net-work of tubules, with wide expansions at the angles; the nodules of lime large, numerous, yellow or greenish-yellow, more or less elongated, lobed, and branched. Spores globose or somewhat irregular, very minutely warted, violaceous, 9–11 mic. in diameter.

Growing on old leaves, mosses, etc. Sporangia .5–.8 mm. in diameter, occasionally by confluence more elongated. Though found in all parts of the country, the species seems rare. This is not the *Physarum virescens* described by Rostafinski.

26. PHYSARUM RUBIGINOSUM Fr. Sporangia subglobose, sessile, gregarious; the wall a thin hyaline membrane, thickly covered with large irregular scales of lime, orange to red or dark red in color, breaking up irregularly. Capillitium of hyaline tubules, forming a loose irregular net-work, more or less expanded at the angles; the nodules of lime large, angular, and irregular, sometimes confluent, orange to dark red in color. Spores globose, very minutely warted, dark violaceous, 9–11 mic. in diameter.

Growing on old wood, leaves, mosses, etc. Sporangia .6–.8 mm. in diameter. *Physarum fulvum* Fries S. M., III, p. 143. A rare species. It should not be confounded with *Physarum lateritium*.

27. PHYSARUM SERPULA Morgan, *n. nom.* Plasmodiocarp roundish or oblong to much elongated, bent, annular and flexuous, sometimes by confluence branched and reticulate; the wall a firm yellowish membrane, with a thin, rough, closely adherent coat of granules of lime, dull ochre to lemon-yellow and orange in color. Capillitium a dense net-work of tubules, for the most part filled with lime, only here and there short, slender, empty spaces; the nodules large, numerous, white or yellow, angular and with pointed lobes and branchlets. Spores globose, minutely warted, dark violaceous, 9–11 mic. in diameter.

Growing on leaves, bark, lichens, etc. Plasmodiocarp .3–.4 mm. in thickness and of varying length. This species is in the herbarium of Schweinitz, at Philadelphia, with the name *Physarum reticulatum;* it is described by George Massee as *Physarum gyrosum;* by Lister it is incorporated with several other species under *Badhamia decipiens.*

28. PHYSARUM CONTEXTUM Pers. Sporangia sessile and closely crowded together, roundish or more or less elongated, flexuous and complicate, the apex plane or impressed; the wall a firm yellowish membrane, covered by a thick pulveraceous layer of lime, white, ochraceous or yellow, easily crumbling and breaking up. Capillitium a loose net-work of tubules, much expanded at the angles; the nodules of lime very large, white or yellow, numerous, angular, and irregular, by confluence lobed and branched, sometimes massed together in the center of the sporangium. Spores globose, minutely warted, dark violaceous, 10–13 mic. in diameter.

Growing on bark, leaves, mosses, etc. Sporangia with a width of .3–.5 mm. and varying in length from .5 mm. to 1 or 2 mm. The sporangia are often so much crowded as to appear to be grown together. *Diderma ochroleucum* B. & C. belongs to this species. *Physarum conglomeratum* Fr. is a closely related species, with smaller and smoother spores. I have not met with this.

29. PHYSARUM DIDERMA Rost. Sporangia large, irregularly globose or oblong, sessile, but without a hypothallus, closely crowded together and sometimes confluent. The wall composed of two distinct and separate layers; the outer a

thick, uneven, crustaceous, snow-white layer of lime; the inner a thin, violaceous membrane, cinereous from the adherent granules of lime, or free from them, and iridescent. Capillitium of tubules forming a loose net-work, with wide expansions at the angles; the nodules of lime numerous, snow-white, large, irregular, with pointed angles and lobes, sometimes confluent in the center of the sporangium. Spores globose, minutely warted, dark violaceous, 9–10 mic. in diameter.

Growing on wood, bark, and mosses. Sporangia .8–1.0 mm. in diameter, more or less irregular. The wall of the sporangium is exactly like that of certain species of *Diderma*. This species must be rare, as I have met with it but twice in ten years, and I am not aware that it has ever been found by any one else.

VIII. FULIGO Haller. Aethalium a compound plasmodiocarp; the component sporangia branching and anastomosing in every direction, complicate and grown together; the walls of the sporangia a thin membrane, coated with minute, roundish granules of lime. Capillitium of tubules forming a net-work of irregular meshes, more or less expanded at the angles, the tubules containing in greater or less abundance irregular nodules of lime. Spores globose or sometimes ellipsoidal, violaceous.

The genus is readily distinguished from *Spumaria* by the round granules of lime upon the walls of the sporangia.

§1. AETHALIUM Link. Aethalia large; the lime in the capillitium scanty, the nodules small, ellipsoidal, or fusiform.

a. Aethalium with a thick fragile common cortex.

1. FULIGO RUFA Pers. Plasmodium a large soft mass with a peculiar odor and golden-yellow in color. Aethalium very large, pulvinate, orbicular, elongated, or quite irregular, extremely friable, the surface tawny or ferruginous to ochraceous and whitish. The long narrow, sinuous sporangia closely compacted, entirely grown together and inseparable, covered by a thick common cortex, and seated on a much

thickened hypothallus; walls of the sporangia a thin pellucid membrane, coated by a thin layer of white granules of lime. Capillitium of very slender tubules, extending across from wall to wall, sparingly branched and scarcely forming a net-work, not at all or only slightly expanded at the angles; the tubules for the most part empty, here and there with slight fusiform or elongated swellings containing granules of lime, occasionally bearing roundish or ellipsoidal nodules of larger size. Spores globose, nearly smooth, violaceous, 6–9 mic. in diameter.

Growing on old trunks in woods in great abundance from early Spring to Winter. Aethalium 3–6 or sometimes many centimeters in extent and 1–2 cm. in thickness. The common cortex and the hypothallus are a millimeter or more in thickness; they are composed of successive layers of thin plates of membrane coated with granules of lime.

b. Aethalium naked, i. e., without a common cortex.

2. FULIGO VIOLACEA Pers. Plasmodium a soft effused mass, dark red or wine-colored. Aethalium large, pulvinate or effused, orbicular or more or less elongated and irregular, the surface minutely pitted and perforate, furnished with a scanty layer of lime, whitish or yellowish to brick-red in color, leaving naked purple and violet spots and patches, seated on a thin membranaceous brick-red hypothallus. Sporangia long, narrow, and sinuous, closely packed together; the walls a thin violaceous membrane, rugulose and iridescent, with scattered granules, or nearly destitute of lime. Capillitium of slender violet tubules, forming a loose net-work, with slight expansions at the angles; the tubules with numerous rather large vesicular expansions, ellipsoid or fusiform in shape, and scantily furnished with lime. Spores globose, nearly smooth, pale vinous, 6–8 mic. in diameter.

Growing on old trunks in woods; not uncommon in this region. Aethalium 1–3 or more centimeters in extent, and 5–10 mm. in thickness. The vesicles of the capillitium vary from 15–30 or sometimes to 50 mic. in diameter. their inner surface is usually coated by a single layer of granules of lime, they are rarely filled with lime and sometimes are naked entirely; when dry many of them are to be found collapsed.

3. FULIGO FLAVA Pers. Plasmodium effused lemon-yellow. Aethalium mostly effused, irregular, the surface reticulate, pitted and perforate, entirely naked, pale yellow to lemon-yellow and greenish-yellow, the hypothallus thin or scarcely evident. Sporangia laterally much compressed, flexuous, and gyrose, not everywhere grown together, but forming a dense reticulum; the walls a thin, pellucid membrane, with a dense layer of lemon-yellow granules of lime. Capillitium of short and very slender tubules, sparingly branched and scarcely forming a net-work, not expanded at the angles; the tubules very scantily furnished with lime, in scattered, small, fusiform nodules, white or lemon-yellow. Spores globose, very minutely warted, violaceous, 7–9 mic. in diameter.

Growing on mosses, old leaves, sticks, etc.; not common. Aethalia in irregular patches 2–4 cm. or more in extent, sometimes almost reduced to a simple plasmodiocarp. This species furnishes a clear notion of the structure of the aethalium in the other species, on account of the sporangia being but loosely compacted and not entirely grown together. The *Fuligo vaporaria* Pers., of the green-houses and gardens I have never seen; the *Mucor septicus* Linn., was thought to be the plasmodium of this. Linnæus's description is simply "*Mucor unctuosus flavus.*"

§2. AETHALIOPSIS Zopf. Aethalium small; lime abundant in the capillitium, the nodules numerous and large, angular and irregular.

4. FULIGO MUSCORUM A. & S. Plasmodium effused, golden yellow. Aethalium small, subpulvinate, irregular, the surface furnished with scattered, irregular scales of lime, whitish or ochraceous to golden yellow in color, arising from a thin, white, membranaceous hypothallus. Sporangia closely packed and grown together; the walls a thin, violaceous membrane, rugulose, with a thin, closely adherent layer of granules of lime. Capillitium a loose net-work of tubules, widely expanded at the angles; the tubules for the most part filled with lime, the nodules white or yellowish, numerous, very large, angular and irregular, sometimes confluent with pointed lobes and branchlets. Spores irregularly globose, minutely warted, dark violaceous, 9–11 mic. in diameter.

Growing on leaves, twigs, mosses, etc. Aethalium from 2 or 3 mm. to a centimeter or more in extent. I have a specimen of *Fuligo simulans* Karsten, from Karsten himself; it is identical with my specimens of *Fuligo ochracea* Peck. There could be no better representation of these specimens made at that time than the description and figure of *Fuligo muscorum* A. & S., in the *Conspectus*.

5. FULIGO CINEREA Schw. Plasmodium milk-white, changing to cinereous. Aethalium effused, variable in extent, the surface rugulose and perforate, white, the hypothallus thin or scarcely evident. Sporangia variously contracted and grown together, forming a dense reticulum; the walls a thin pellucid membrane, with a thick white outer layer of granules of lime. Capillitium a loose net-work of tubules, widely expanded at the angles, the tubules for the most part filled with lime, the nodules white, numerous, very large, angular, and irregular, lobed and branched. Spores globose or oval, minutely warted, dark violaceous, 10–15 x 10–12 mic.

Growing on old leaves, herbaceous stems, etc. I find it most abundantly about the horse barn, upon the old straw and manure, sometimes running out onto the green herbage. Aethalium from a few millimeters to several centimeters in extent. Upon the testimony of Dr. Geo. A. Rex this is both *Enteridium cinereum* and *Lachnobolus cinereus* of Schweinitz's *North American Fungi* as represented in his herbarium. It is *Physarum ellipsosporum* of Rostafinski. It is no doubt also *Aethaliopsis stercoriformis* Zopf.

IX. BADHAMIA Berk. Sporangia large, subglobose or obovoid, sometimes depressed, substipitate or sessile; the wall a thin membrane, with an outer layer of minute roundish granules of lime, irregularly dehiscent. Stipe poorly developed, sometimes a mere strip of the hypothallus, often wanting. Capillitium of thick tubules, attached on all sides to the wall of the sporangium, combined into a net-work of large meshes, more or less expanded at the angles; the tubules containing minute roundish granules of lime throughout their whole extent. Spores large, subglobose, dark violaceous.

The peculiar character of this genus is that the granules of lime are distributed along the whole interior of the tubules of the capillitium; this makes the net-work rigid, and on this account a firmer support for the wall of the sporangium.

1. Badhamia capsulifera Bull. Sporangia subglobose or obovoid, sessile, on a thin pallid or yellowish hypothallus, which sometimes sends out narrow bands or strings of membrane of variable length, bearing sporangia singly or in clusters. Wall of. the sporangium a thin pellucid membrane, mostly even or somewhat rugulose and iridescent, coated by a very thin layer of white granules of lime. Capillitium of rather slender tubules, forming an open net-work of very large meshes, only slightly expanded at the angles; the tubules coated within by a very thin layer of white granules of lime. Spores subglobose or obovoid, adhering together in clusters of six to twenty or more, distinctly warted on the outer exposed surface, dark violaceous, 10–13 mic. in diameter.

Growing on old bark, leaves, etc. Sporangia .8–1.4 mm. in diameter. *Badhamia hyalina* and *B. capsulifera* of Rostafinski's monograph are here included together; he distinguished the former by the "sporangia in clusters always exactly globose," a distinction first made by Chevallier; otherwise the characters are the same in both.

2. Badhamia utricularis Bull. Sporangia subglobose or obovoid, sessile, on a thin pallid or yellowish hypothallus, which often separates into narrow strips and strings of membrane of variable length, bearing the sporangia singly or in clusters. Wall of the sporangium a thin violaceous membrane, rugulose and iridescent, shining with purple, blue, and violet tints, with a thin layer of white granules of lime. Capillitium of thick tubules, forming an open net-work of large meshes, more or less expanded at the angles, the tubules coated within by a thin layer of granules of lime. Spores subglobose. minutely warted, dark violaceous, 10–13 mic. in diameter.

Growing on old wood, bark, herbaceous stems, etc. Sporangia .5–1.0 mm. in diameter, usually growing in clusters, sometimes suspended by the strings of membrane. Rostafinski's distinction between this and the preceding species in

regard to the spores holds good so far as my specimens are concerned. *Badhamia magna* Peck, I have never seen. George Massee includes all four of these species in one composite species, which he names *Badhamia varia*.

3. BADHAMIA PAPAVERACEA B. & Rav. Sporangia subglobose or obovoid, substipitate or sessile, growing close together; the wall a thin violaceous membrane, rugulose and iridescent, with a very thin coat of white granules of lime. Stipe very short, brown or blackish, sometimes reduced to merely a thickened blackish base to the sporangium. Capillitium of thick tubules, forming an open net-work of large meshes, more or less expanded at the angles; the tubules with an inner lining of very minute white granules of lime. Spores adhering together in clusters of six to twenty, each spore subobovoid, the free portion more distinctly warted, 10–12 mic. in diameter.

Growing on old wood, bark, etc. Sporangia .6–1.0 mm. in diameter. Readily distinguished by its black base or black stipe and the elegant clusters of its spores, which stick together most persistently.

4. BADHAMIA ORBICULATA Rex. Sporangia much depressed, orbicular or somewhat irregular, umbilicate often both above and below, gregarious, sometimes growing close together and confluent, stipitate or sessile. The wall a thin pellucid membrane, with a thin layer of minute granules of lime, which are sometimes raised into small scales and fine ridges. Stipe very short, black, sometimes reduced to merely a blackish base to the sporangium. Capillitium of thick tubules, forming a scanty irregular net-work, with wide expansions at the angles; the tubules filled with white granules of lime. Spores subglobose, very minutely warted, dark violaceous, 12–15 mic. in diameter.

Growing on old bark, herbaceous stems, etc. Sporangia .4–.8 mm. in diameter, sometimes by confluence larger. This species seems near *Badhamia verna* Smfdt, but the latter everywhere is described as sessile, while in the former the short black stipe is nearly always distinguishable.

5. BADHAMIA AFFINIS Rost. Sporangium hemispherical, or much depressed, the base flattened or umbilicate, stipitate,

erect or often cernuous; the wall a thin pellucid membrane, coated with minute white granules of lime, which are frequently raised into scales and ridges. Stipe short, erect or bent at the apex, black, expanding at the base into a small hypothallus. Capillitium of thick tubules, forming an open net-work of large meshes, more or less expanded at the angles; the tubules filled with white granules of lime. Spores subglobose, minutely warted, dark violaceous, 14–18 mic. in diameter.

Growing on mosses and upon the bark of maple trunks. Sporangium .6–1.0 mm in diameter, the stipe about the same length. Rostafinski's description is based upon a specimen found in Chili, South America, by Bertero; it is recorded in this country by Peck. I find it in some seasons quite abundant. The spores are very large, in some specimens averaging 17 mic.

6. Badhamia decipiens Curtis. Sporangia gregarious, sessile, globose, oval or oblong, by confluence sometimes more elongated; the wall a somewhat thickened and firm yellow or yellow-brown membrane, covered with large, thick scales of lime, tawny to golden yellow or orange in color. Capillitium of thick tubules, forming an open network, more or less expanded at the angles; the tubules filled throughout with yellow granules of lime. Spores globose, very minutely warted, lilac, 10–12 mic. in diameter.

Growing on old wood and bark. Sporangia .6–1.0 mm. in length by .6–.7 mm. in thickness. My specimens were determined by Dr. George A. Rex by comparison with a specimen from Curtis in the herbarium of the Philadelphia Academy of Sciences. This species should not be confused with what we have described as *Physarum serpula*. *Physarum chrysotrichum* B. & C., is no doubt the same thing. *Badhamia nitens* Berk., which is also golden yellow, has not yet been found in this country; it will readily be distinguished from the present species by its clustered spores.

7. Badhamia panicea Fr. Sporangia sessile, subglobose or oblong, more or less irregular, gregarious; the wall a thin, pellucid membrane, covered with large, irregular, very thick, white scales of lime. Capillitium of thick tubules, forming a

loose net-work of rather small meshes, with wide expansions at the angles; the tubules filled with white granules of lime, sometimes confluent toward the base of the sporangium. Spores subglobose, very minutely warted, dark violaceous, 11–14 mic. in diameter.

Growing on old wood, bark, leaves, etc. Sporangia .8–1.6 mm. in length, with a thickness of .7–1.0 mm. This species appears to be rare; the only specimens known to me in this country I have from Professor Thos. A. Williams, of South Dakota; they are identical with European specimens received from Lister. *Physarum paniceum* Fries, S. M., III, p. 141; it approaches *Physarum cinereum* Batsch.

8. BADHAMIA LILACINA Fr. Sporangia globose or obovoid, sessile or rarely substipitate, closely crowded together on a thin, brownish hypothallus; the wall a firm, hyaline membrane, with a thick, smooth, continuous outer-layer of lime, varying in color from gray-white or drab to lilac and flesh color. Capillitium of very thick tubules, forming a dense net-work of small meshes; the tubules stuffed with granules of lime, which are white or colored somewhat as those in the wall, often confluent in the center of the sporangium. Spores globose, minutely warted, dark violaceous, 11–14 mic. in diameter.

Growing on wood, leaves, mosses, etc. Sporangium .5–.7 mm. in diameter. The outer crustaceous layer of lime on the wall crumbles and falls away, as in some species of *Diderma*. The white form is *Diderma concinnum* B. & C.; the lilac or flesh-colored form is *Physarum lilacinum* of Fries, S. M., p. 141. I have seen it colored only white and drab. Under a high magnifying power the sculpturing of the spores is seen to be peculiar.

X. SCYPHIUM Rost. Sporangium obovoid to oblong-obovoid, stipitate or subsessile; the wall a thickened, brownish membrane, the surface entirely naked or only the upper portion covered with granules of lime, breaking up irregularly about the apex. Stipe variable in length, arising from a common hypothallus and prolonged within the sporangium as a columella. Capillitium of thick tubules, proceeding from numerous points of the columella and forming a dense net-

work; the tubules filled with lime throughout their whole extent. Spores large, subglobose, dark reddish-brown.

This genus differs from *Badhamia* by the columella which gives origin to the capillitium. The sporangia in the species composing it, resemble those of *Craterium*, and to this genus they are referred by Massee, but the capillitium is that of *Badhamia*.

1. SCYPHIUM RUBIGINOSUM Chev. Sporangia gregarious, obovoid, stipitate; the wall a thickened reddish-brown membrane, the upper part covered by a thin layer of white granules of lime, the lower basal portion naked, strongly venulose and more persistent. Stipe long, erect, reddish-brown, expanding at the base into a brown hypothallus, prolonged within the sporangium to more than half its height as a columella. Capillitium of thick tubules, forming a dense net-work of small meshes; the tubules stuffed with white granules of lime. Spores irregularly globose, minutely warted, dark reddish-brown, 12–15 mic. in diameter.

Growing on old wood, mosses, etc. Sporangia .6–.8 mm. in height by .5–.6 mm. in diameter, the stipe from once to twice the height of the sporangium. This is *Physarum rubiginosum* Chevallier, *Flor de Paris*. It is also *Craterium obovatum* Peck.

2. SCYPHIUM CURTISII Berk. Sporangia oblong-obovoid, stipitate or subsessile, usually growing in clusters; the wall a thick, firm, reddish-brown membrane, venulose and reticulate, nearly destitute of lime. Stipes variable, commonly very short, sometimes confluent, arising from a brown hypothallus, prolonged within the sporangium to about half its height. Capillitium of thick tubules, forming a dense network of small meshes; the tubules stuffed with white granules of lime. Spores irregularly globose, minutely warted, dark reddish-brown, 12–15 mic. in diameter.

Growing on old wood, leaves, grass, etc. Sporangium .4–.7 mm. in height by .3–.4 mm. in diameter, the stipe often reduced to a mere point or cushion on the hypothallus, and varying thence to nearly the length of the sporangium. The sporangium is narrower than in the preceding species, and the brown wall is usually without granules of lime. It is *Didymium curtisii* Berk. Rostafinski and Massee both preserve it distinct from *S. rubiginosum*.

EXPLANATION OF PLATE I.

Fig. 49.—Angioridium sinuosum Bull. *a.* Plasmodiocarp × 5. *b.* Capillitium and spores × 500.

Fig. 50.—Cienkowskia reticulata A. & S. *a.* Plasmodiocarp × 5. *b.* Piece of plasmodiocarp × 90. *c.* Capillitium and spores × 500.

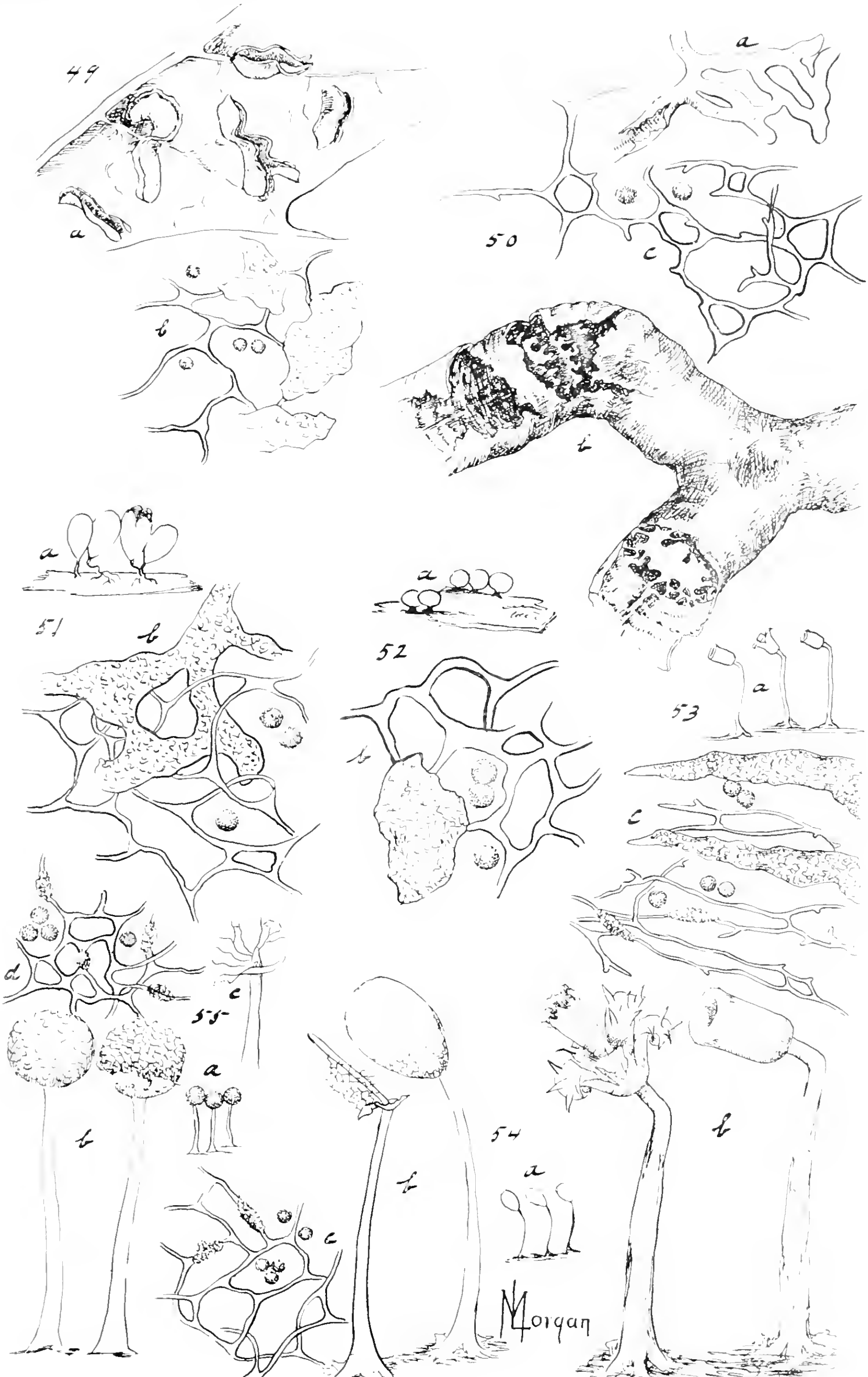
Fig. 51. Leocarpus fragilis Dicks. *a.* Sporangia × 5. *b.* Capillitium and spores × 500.

Fig. 52. Leocarpus caespitosus Schw. *a.* Sporangia × 5. *b.* Capillitium and spores × 500.

Fig. 53.—Physarella oblonga B. & C. *a.* Sporangia × 5. *b.* Sporangia × 90. *c.* Capillitium and spores × 500.

Fig. 54. Cytidium penetrale Rex. *a.* Sporangia × 5. *b.* Sporangia and columella × 90. *c.* Capillitium and spores × 500

Fig. 55.—Cytidium globuliferum Bull. *a.* Sporangia × 5. *b.* Sporangia × 90. *c.* Columella × 90 *d.* Capillitium and spores × 500.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EXPLANATION OF PLATE II.

Fig. 56.—Craterium minimum B. & C. *a.* Sporangia × 5. *b.* Sporangium with lid × 90. *c.* Capillitium and spores × 500.

Fig. 57.—Craterium maydis Morgan. *a*, Sporangia × 5. *b.* Sporangium × 90. *c.* Capillitium and spores × 500.

Fig. 58.—Physarum obrusseum B. & C. *a.* Sporangia × 5. *b.* Sporangium × 90. *c.* Capillitium and spores × 500.

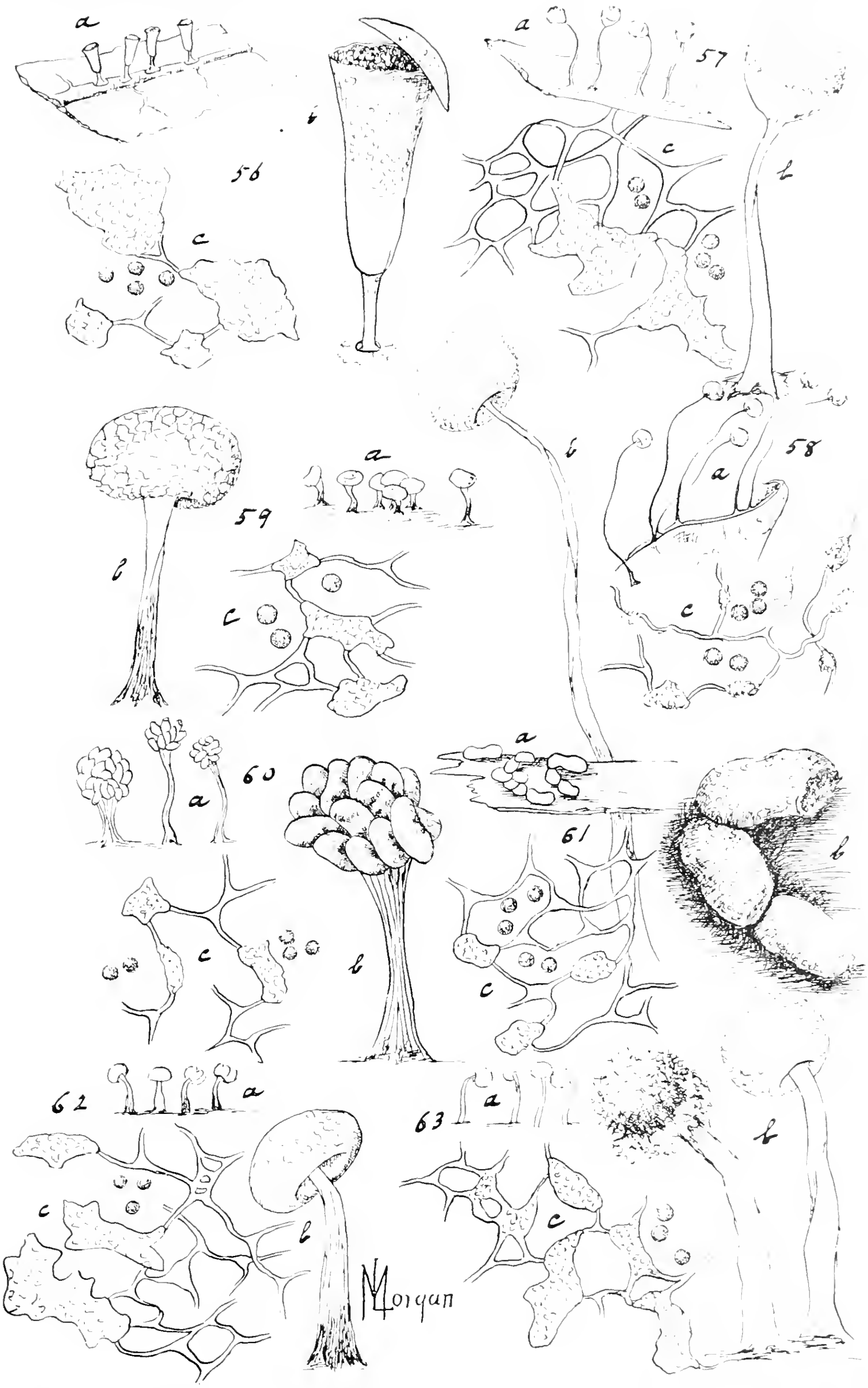
Fig. 59.—Physarum connexum Link. *a.* Sporangia × 5. *b.* Sporangium × 90. *c.* Capillitium and spores × 500.

Fig. 60.—Physarum polycephalum Schw. *a.* Sporangia × 5. *b.* Sporangia × 90. *c.* Capillitium and spores × 500.

Fig. 61.—Physarum lateritium B. & C. *a.* Sporangia × 5. *b.* Sporangia × 90. *c.* Capillitium and spores × 500.

Fig. 62.—Physarum imitans Racib. *a.* Sporangia × 5. *b.* Sporangium × 90. *c.* Capillitium and spores × 500.

Fig. 63.—Physarum relatum Morgan. *a.* Sporangia × 5. *b.* Sporangia × 90. One divested of the wall and showing the rigid capillitium. *c.* Capillitium and spores × 500.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EXPLANATION OF PLATE III.

Fig. 64.—Physarum glaucum Phillips. *a.* Sporangia × 5. *b.* Sporangium × 90. *c.* Capillitium and spores × 500.

Fig. 65.—Physarum serpula Morgan. *a.* Plasmodiocarp × 5. *b.* Piece of plasmodiocarp × 90. *c.* Capillitium and spores × 500.

Fig. 66.—Fuligo violacea Pers. *a.* Aethalium natural size. *b.* Capillitium and spores × 500.

Fig. 67.—Fuligo flava Pers. *a.* Portion of an aethalium × 5. *b.* Capillitium and spores × 500.

Fig. 68.—Fuligo cinerea Schw. *a.* Portion of aethalium × 5. *b.* Capillitium and spores × 500.

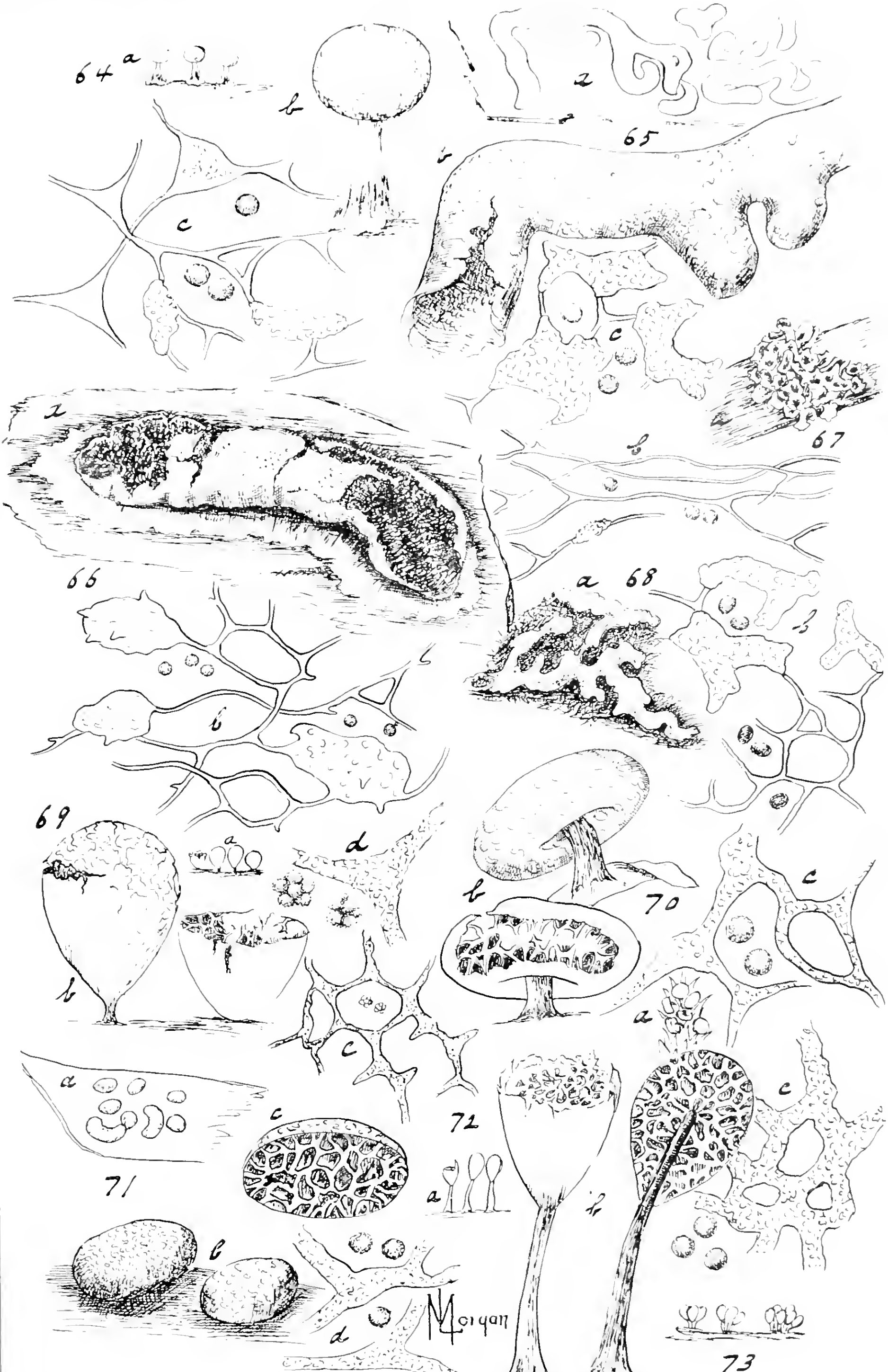
Fig. 69.—Badhamia papaveracea B. & Rav. *a.* Sporangia × 5. *b.* Sporangium together with transverse section × 90. *c.* Capillitium and spores × 90. *d.* Portion of capillitium with clustered spores × 500.

Fig. 70.—Badhamia affinis Rost. *a.* Sporangia × 5. *b.* Sporangia × 90, one with section showing capillitium. *c.* Capillitium and spores × 500.

Fig. 71.—Badhamia decipiens Curtis. *a.* Sporangia × 5. *b.* Sporangia × 90. *c.* Section of sporangium showing capillitium. *d.* Capillitium and spores × 500.

Fig. 72.—Scyphium rubiginosum Chev. *a.* Sporangia × 90. *b.* Sporangia × 90, with section showing capillitium. *c.* Capillitium and spores × 500.

Fig. 73.—Scyphium curtisii Berk. Sporangia × 5.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ARTICLE II.—ON THE CORRECT POSITION OF THE APERTURE IN PLANORBIS.

BY FRANK C. BAKER, B. S.

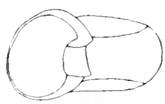
In 1881,* Dr. R. E. C. Stearns, in a somewhat exhaustive article, gave as his opinion that the shells of *Planorbis* were nearly all sinistral and not dextral, as most authors have described them. With a view to establishing this fact beyond a doubt for a number of the species, I set about the examination of the material in the Chicago Academy of Science, with some very interesting results. As suggested by Dr. Stearns in his paper (l. c., p. 96), I examined a large number of Planorbes by breaking away all the whorls save the two or three nuclear whorls. This was comparatively easy for the larger forms, but quite difficult for the smaller species. The result shows what a little time and patience will do in settling a disputed point of this kind. In almost every shell examined, I was able to reduce the adult shell to a form much resembling a *Physa* with the apex cut off, the apical whorls above and the umbilicus below, the aperture, as in *Physa*, to the left hand. By reducing all the species to this condition, I was able to see with absolute certainty the position of the aperture. Many of the earlier authors, as Say, Reeve, G. B. Sowerby, Jr., etc., treated the group as sinistral, but most modern authors have considered it dextral, and so figured and described it. That the majority of them were wrong in so describing them, I trust I shall demonstrate in this communication.

Before entering upon a consideration of the different species, it might be well to consider the relation of the shell to the animal, as well as some particular points in the shell itself. The shell is carried perpendicularly when the animal is in motion, thus presenting a right and left side. This fact

*Are the shells of Planorbis Dextral or Sinistral? Proc. Acad. Nat. Sci., Phil., p. 92, 1881.

caused several conchologists to describe the upper and lower surfaces as the right and left sides. A mollusk living in this manner would naturally acquire a discoidal shell, and the coils might not always be in the same plane. This is the case with *Planorbis*, for we often find examples of the same species which have the last one, two or three whorls either above or below the median peripheral line of the whorls. We find frequently that the apex and umbilicus are both more or less perforating. This results in this manner: when the shell is young the height is say one-eighth of an inch; the next two turns raise the general height to one quarter, and the original apex is depressed below the level of the last whorl. This continues until the adult form is reached, when we have a species like *ammon* or *trivolvis*. I have known of cases where the apex and umbilicus were so close together that the apex finally became perforated, making a hole clear through the shell. The animal is essentially sinistral, the generative, respiratory, and excretory orifices being on the left side. The following species have been critically examined, and I believe the determinations can be depended upon:

PLANORBIS TRIVOLVIS Say. I reduced this species to one and a half whorls with results of a positive nature. The apical whorls were distinctly flat and regular, while the umbilical region was deeply perforated. There is no question concerning the sinistrality of this species.



PLANORBIS TRIVOLVIS Say. Adult form.

PLANORBIS TRIVOLVIS, Say. Young specimen of 2½ whorls, showing sinistral character.

PLANORBIS TRUNCATUS Miles, is decidedly sinistral, a fact which is at once apparent without the trouble of dissection. I am able to add two new localities to the original one at Saginaw Bay, Michigan; these are, Miller's, Indiana, and North Branch of the Chicago River, near Bowmanville.

PLANORBIS CAMPANULATUS Say. This species is sinistral, though at first sight it is taken for dextral. It is only after the shell has been reduced to two or three whorls that the sinistral character is seen. The umbilicus is not deep in this species, as it is in *trivolvis*.

Planorbis bicarinatus Say, is very difficult to decide upon from the adult shells, for the entire number of whorls may be counted on both sides. It was only by reducing the shells to two whorls that I was enabled to absolutely determine its sinistral character. I was much astonished, also, to find that these dissected shells corresponded exactly to numerous very small Planorbes which have puzzed me for some time. It is more than probable that all the young of Planorbis show distinctly their sinistral character.

Planorbis subcrenatus Cpr., is also sinistral, but is only seen to be such after dissection.

Planorbis glabratus Say. This is very closely allied to *trivolvis*, and, like that species, it is sinistral.

Planorbis ammon Gould, is sinistral, a fact easily ascertained by a close examination, even without the trouble of a dissection. By breaking away to the second whorl, the sinistral character is seen to be quite pronounced. The umbilical region is much indented.

Planorbis corneus Limé, is sinistral.

Planorbis corpulentus Say, is sinistral, and, if I mistake not, will prove to be a synonym, or at most a variety, of *trivolvis*. The two species merge into one another, as may be seen by examining a large series of both.

Planorbis lentus Say. This species is sinistral, and is also very closely related to *trivolvis*. Its distribution, however, is essentially southern.

Planorbis oregonensis Tryon is sinistral. The aperture is greatly deflected on the lower extremity, a fact which goes a great way toward placing it in the right position.

Planorbis exacutus Say, is dextral.

Planorbis parvus Say, is dextral.

It is very difficult to experiment with these small and fragile shells. Several specimens of *exacutus* I have been able to examine with some degree of success, but, as a rule, the results were not satisfactory. I am firmly convinced, however, that the two species spoken of are dextral.

Segmentina armigera Say, is dextral. It will be seen from the above that the larger species of *Planorbis* are sinis-

tral, while most of the smaller forms are dextral. In regard to the position of the genus, much has been said and written. By some authors it is considered nearly related to *Physa*, and by others to *Limnæa*. My observations have convinced me that the genus is closely related to both, its sinistral shell, as seen in dissected specimens, shows that it is closely related to *Physa*, while its dentition and jaw show it to be nearer *Limnæa*. *Planorbis* has subquadrate teeth, which are bi- and tricuspid for the most part, save the marginals which are serrated. *Physa*, on the other hand, has a small central tooth and numerous comb-like lateral teeth. When a revision of the genus is made, all of the species should be subjected to an examination, similar to that which I have given the forms spoken of in this paper.

ARTICLE III.—DIEMYCTYLUS VIRIDESCENS *var.* VITTATUS, A NEW VARIETY OF THE RED-SPOTTED TRITON.

BY PROFESSOR H. GARMAN, LEXINGTON, KY.

With a series of black-bordered, longitudinal red lines, forming together a broken subdorsal stripe on each side. Pale greenish olive above, golden yellow below, the two colors terminating abruptly where they meet on the sides; everywhere with round, black spots. Length, 70 mm.

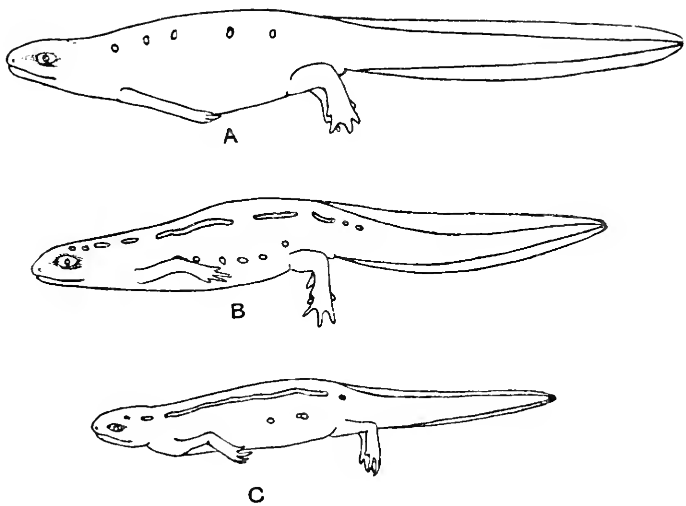
Similar to the common northern variety of *D. viridescens*, but averaging smaller, and to be distinguished at once by the broken subdorsal line. The line begins above the eye as small, round spots, those of the two sides sometimes diverging from a median spot between the eyes. Following the spots are a few short dashes on the posterior part of the head, which, in turn, are followed by lines varying from 3 to 20 mm. in length and constituting the greater part of the length of the series. The series extends a little beyond the base of the hind leg, and is completed on the base of the tail by several small, round dots. In some examples the lines are bordered uniformly with black, but in others the black is distributed as dots along the red lines, as if indicating the position of ocellate spots, which, by elongation and fusion, have formed the lines. The spots of an inferior series, present on each side between the bases of the legs, also show a tendency to elongation, and dashes of as much as 3 mm. long sometimes occur among them. The black dots scattered everywhere over the body and its appendages vary in size and number in different individuals. On the tail they are sometimes surrounded by a wide, nebulous, dusky border. A dusky band on each side of the head is always present, but varies much in brightness. Females are larger, lighter in general color, and the subdorsal lines have in them more frequent interruptions. The terrestrial stage (corresponding to the form

miniatus of the common variety) is reddish brown, lacks the membranous expansions of the tail, and has minutely granulate skin. The single example of this form collected has the characteristic subdorsal lines less interrupted than usual.

In the following list of measurements the length of the body is the distance from the tip of the snout to the posterior limit of the anal protuberance :

1.	Length of body......30	mm.	1.	Length of tail........27	mm.
2.	" " 32	"	2.	" " 31	"
3.	" " 34	"	3.	" " 31	"
4.	" " 34	"	4.	" " 34	"
5.	" " 34	"	5.	" " 36.5	"
6.	" " 35	"	6.	" " 26	"
7.	" " 35	"	7.	" " 35	"
8.	" " 35	"	8.	" " 35	"
9.	" " 35	"	9.	" " 40	"
10.	" " 36	"	10.	" " 36	"
11.	" " 37	"	11.	" " 37	"
12.	" " 37	"	12.	" " 37	"
13.	" " 37	"	13.	" " 38	"
14.	" " 37	"	14.	" " 39	"
15.	" " 38	"	15.	" " 37	"

This triton occurs abundantly in shallow pools near Wilmington, North Carolina. Numerous examples (including the



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material in the Museum of Comparative Zoölogy at Harvard University) of the common variety from various localities, North and South, have been compared with the specimens from Wilmington, and while a good deal of variation in the size and number of the ocellate spots was noted, in none was there a tendency to the formation of lines. The specimens from Wilmington are, on the contrary, invariably lineate.

An examination of several stomachs of individuals taken July 28th showed them to be feeding on insects and crustaceans. Of insects a Corisa, larvæ of Culex, Chironomus, of Agrionina, and Libellulina were determined. With the exception of a small Cambarus, the crustaceans all belonged to the groups Phyllopoda and Ostracoda. Desmid and filamentous algæ noted had probably been taken accidentally with animal food.

Explanation of Figures.

A. *D. viridescens*, var. *viridescens* (aquatic form).
B. *D. viridescens*, var. *vittatus* (aquatic form).
C. *D. viridescens*, var. *vittatus* (terrestrial form).

Natural size. The scattered black spots not represented.

ARTICLE IV.—SOME NOTES ON THE MAMMALS OF MAMMOTH CAVE, KENTUCKY.

BY SAMUEL N. RHOADS, PHILADELPHIA, PA.

(The "notes," which constitute the body of this paper, were prepared by Mr. Rhoads for use in another place and publication. But so little is known of the mammals of caverns, and the present impossibility of presenting this matter in the form originally intended have influenced the writer to present them through the Cincinnati Society of Natural History. It is but just to Mr. Rhoads to say that this disposition of his "notes" is wholly on the authority of the writer, for whom they were made. At some future time another contribution may be offered, which will be complete, for the fauna and flora of the great cavern.—*R. Ellsworth Call.*)

Alleghany Cave Rat. NEOTOMA MAGISTER Baird.

"Rat of the Blue Mountains: Bartram," in Kalm's Trav. (Forsters's ed.), 1771, pp. 47-48.

American Rat: Pennant, Hist. Quad., 1781, p. 441 (quotes Kalm).

Neotoma floridana Baird: Mam. N. Amer., 1857, p. 489 (in part; name applied to New York specimens in National Museum).

Neotoma magister Baird: Mam. N. Amer., 1857, p. 498 (Rhoads' Reprint Ords' Zool., Sept., 1894, appx., p. 16; Proc. Acad. Nat. Sci., Phila., Oct., 1894, pp. 213-221; ibid., 1896, p. 192).

Neotoma pennsylvanica Stone: (Proc. Acad. Nat. Sci., Phila., 1893, p. 16; Merriam, ibid., 1894, p. 244.)

Geographic distribution. Alleghanian fauna, extending northeastward along the Blue Ridge to isolated localities in southern New York, eastern Massachusetts (?) and Connecticut (?), southward to Alabama, and west to Mammoth Cave, Kentucky.

Habitat. Cliffs, caves, and rock ledges of the mountains, descending into the lowlands, where limestone caves afford it security.

Habits. For a description of the habits of this animal in its Pennsylvania haunts, the reader is referred to my paper, above quoted, in the Proceedings of the Philadelphia Academy.

My experience with the Cave Rat in Kentucky is confined to an unsuccessful attempt to capture them in Mammoth Cave during a visit there in April, 1895, in company with Professor R. E. Call. At that time I examined their rendezvous and conversed with some of the guides concerning them. Subsequently I received alive an adult male specimen, and studied the habits of the animal in captivity for nearly a month before sacrificing its life to science. More recently an adult female in spirits was sent to me, and these have afforded all the necessary characters by which to fix the status of the rat of Mammoth Cave. Both these specimens were procured by Professor Call and forwarded by him to the Academy of Natural Sciences for identification.

The only place where I noted evidences of this animal in Mammoth Cave was about a quarter of a mile from the entrance, in the wide passageway known as The Main Cave.

Piles of loose stones line the sides of the cavern at this point, and along the foot of the arching walls are strewn the indescribable collection of materials with which this animal is sure to adorn and litter its by-ways. Among these were found the nuts and seeds of various trees and plants growing around the mouth of the cave, showing unmistakably the chief source of their food supply, and that they by no means confine their wanderings to the cave itself. I was unable to find the nests or remains of the rats, but the numberless narrow passageways, stone heaps, and crevices undoubtedly concealed these from search as well as the live animals. Of their numbers it was impossible to get information. The guides rarely see them, and their haunts seem to be largely confined to the particular locality I have mentioned. No instance had come to their (the guides') notice of the rats building a nest openly on the floor of the cave, as has been stated* to be the custom of the same species in the caves of Virginia.

One of the guides assured me that these rats were by no means confined to the cave, but could be found on the rocky

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* See Proc. Acad. Nat. Sci., Phila., 1894, p. 220.

cliffs on the opposite shores of Green River, a half mile distant. There is no doubt that this *Neotoma* is likely to be found in any of the larger caves and more mountainous rocky elevations, which are so numerous in this and other parts of Kentucky. I did not find it, however, in similar situations, in Tennessee, west of the Great Smoky Mountains, but owing to its extremely local and apparently erratic distribution, it may have been overlooked.

The rat from Mammoth Cave, which I kept alive, was so precisely a duplicate, both in appearance and actions, of one I had previously studied and which came from Clinton County, Pennsylvania, that the thought of their being different species or races could not be entertained, and the examination of their anatomy confirms such a negative view.

Any suspicion of blindness or deficient eyesight, such as is exemplified in some of the lower orders of animal life in the cave, can not attach to this mammal. As in all the more strictly nocturnal rodents, the eyes of this species are greatly developed; nevertheless, they are able to make most intelligent use of them in broad daylight, if need be. My pet cave rat was very sleepy in the daytime, and if given the materials would quickly make a globular nest in which to hide. The favorite position of rest was on the side, coiled, with the nose resting on the abdomen and tail curled around the body. It frequently would "sit on its head," as it were, by leaning forward and placing its nose near the root of the tail, that member acting as a sort of prop to prevent the animal from turning a somersault in its sleep. Sometimes it would lie stretched out at full length on its side, the tail straight and the hind feet extended to their farthest limit. It invariably picked up objects with its teeth, though its fore feet were quite capable of the service, and the dexterity with which it would manipulate a nut with one or both paws was astonishing. In eating this kind of food it would quickly rasp a small hole, and, inserting the long lower incisors, clip off pieces of the kernel and extract them with great adroitness through an opening less than a quarter of an inch in diameter. All kinds of vegetable and animal food were acceptable to it, but it seemed to prefer nuts and grain to anything else, though cabbage and apples were a favorite dessert, and it greatly enjoyed sharpen-

ing its teeth on candy toys. It was a great drinker, lapping water like a dog. In defending itself it would stand on its hind legs and strike with great force with the fore feet, at the same time laying hold on an object thrust toward it with great strength and forcing it toward a distant part of the cage. The odor of this animal, even under ordinary conditions of care, is almost suffocating, and far more mephitic than that of the Norway Rat. When investigating an object, the coarse and prominent whiskers of this rat are vibrated with astonishing rapidity, forming a sort of halo about the face because of their incessant motion. The function of these organs must be highly specialized in this *Neotoma*, and undoubtedly has to do with its subterranean habits. On no occasion did any of my caged rats utter a cry, save a sort of grunting squeak when they yawned forcibly.

General characters. Resembling those of the Norway Rat, *Mus decumanus*, in proportion, but distinguished by greater size, larger ears and eyes, thicker, shorter, and more hairy tail, white feet, darker pelage, and enormous whiskers. The skull of this animal is instantly recognizable from that of *Mus decumanus* by its great size, lack of supraorbital ridges, and the flat, prismatic-crowned, molar teeth. It is distinguished from its southern ally, *Neotoma floridana*, by greater size, hairy, bicolored tail and grayer (less brown) color, and cranially by the relatively heavier dentition, smaller auditory bullæ and heavier and blunter rostrum, flattened upper profile, and narrow postpalatal foramen.

Color. Above, uniform tawny, or buffy gray, lined with coarser black hairs, darkest along upper head and back, the buff predominating along the sides; becoming nearly pure along the line of separation from the white of under parts, and reaching down sides of neck to or across the fore breast. Feet from wrists and ankles, white; soles naked, heel hairy. Ears large, rounded, sparsely haired inside and out, a pencil of white hairs at their posterior bases. Upper tail as dark or darker than back, beneath white, like the whole of under parts. Whiskers reaching to or behind shoulders, coarse at base, but finely tapering and elastic, the smaller white, the coarser black, with white tips.

Cranial characters. Greatest length nearly twice the

zygomatic breadth; length of nasals nearly half the basilar length; greatest depth (occipital) about half the length of mandible. Posterior margin of palate acutely emarginate, nearly reaching a line connecting the hinder bases of *m. 3*. Pterygoid fossa narrow and deep, the pterygoid processes much constricted and strongly produced posteriorly below the level of the audital bullæ. Nasals scarcely reaching back to a line connecting the anterior angles of the orbits, and falling short of the premaxillaries in this respect. In yearling adults the molars are sharply angled; *m. 1* having two small anterior and one large transverse median triangles and a posterior lateral loop; *m. 2* is similar with only a single anterior triangle; *m. 3* has an anterior triangle and a deeply indented, almost circular, posterior loop. In very old examples these teeth change materially, becoming broader and much less angular, the tips of adjoining triangles and crescent sometimes joining in a continuous outer enamel wall, and the anterior triangle of *m. 1* resolving into an indented crescentine loop.

Measurements of male specimen, taken before immersion in spirits:

	Millimeters.		Millimeters.
Total length	429	Basilar length	48
Tail vertebræ	190	Greatest breadth	27.5
Hind foot	42	Interorbital constriction	7.2
Height of ear from crown	24	Length of nasals	22
Greatest breadth of ear	22.5	Length of mandible	32.5
Skull, total length	55	Width of mandible	16

General remarks. The above measurements are of an old, adult, male rat, and are about the average of fully-grown specimens of this species. The only difference which seems to be constant to cave-dwelling specimens, as compared with those from more open cliffs and rocky ledges, is the less hairy and markedly unicolored tail. I find that two specimens in the Academy's collection from a cave in Wythe County, Virginia, correspond, in this particular, with those from Mammoth Cave. In all other respects, there are no constant peculiarities in the Kentucky animal which are not shared by Pennsylvania specimens.

For the benefit of those who are unable to look up the literature to which references have been made, it may be stated

that Professor Baird's name of *Neotoma magister* for this rat was originally applied to what he considered a fossil species, described from some lower maxillaries taken in a cave near Carlisle, Pennsylvania. Similar remains were afterward found in other caves, but it was not till 1893 that Mr. Witmer Stone announced the discovery of a living *Neotoma* in the South Mountain, not many miles distant from the Carlisle cavern which produced Baird's types. To this animal Mr. Stone gave the name *Neotoma pennsylvanica.* Not long after I made a comparison of the remains of the extinct(?) rat with Mr. Stone's types, and in "A Contribution to the Life History of the Alleghany Cave Rat" (l. c.) endeavored to show that the living and so-called "fossil" *Neotomæ* were specifically the same. In his Review of the *Neotomyinæ*, (l. c.) Dr. Merriam considers them distinct, but Dr. J. A. Allen, in a recent paper, inclines to the belief that they are identical.

Eastern Deer Mouse. PEROMYSCUS LEUCOPUS Rafinesque.

Musculus leucopus Raf. Amer. Mon. Mag., III, 1818, p. 446.

Peromyscus leucopus Thomas. Ann. and Mag. Nat. Hist., XV, 1895, p. 192.

Geographic distribution. Carolinian fauna, from the Mississippi River to the Atlantic, and from latitude 34° to the Great Lakes.

Habitat. Woodlands; living in hollow logs and subterranean burrows, sometimes nesting in trees.

Habits. The White-footed or Deer Mouse is abundant in the vicinity of Mammoth Cave, where I caught a few during my brief sojourn. Two specimens were taken at the mouth of the cavern, and Professor Call sends me another secured in the cave itself. Of its habits in the cave I know nothing, but its only inducement to enter the place would be in search of such food as the rats scatter in their carnivals or for the insect life which abounds there. It can hardly be considered as more than a transient visitor to Mammoth Cave, as its choice is the open woodlands, and in many respects it shows a more arboreal and less subterranean manner of life than any other of the known American *Muridæ.*

Description. The status of this mouse is so well understood that it is not necessary to more than briefly allude to its several characters. As exemplified in the specimens above mentioned, the Deer Mouse of Central Kentucky may be concisely stated as a miniature of the Cave Rat—something over 6 inches long. In color, pattern and proportions it is the exact counterpart of the rat, but in color the dark, buffy gray of upper parts of that animal is a delicate, grayish fawn in the adult mouse. The specimen sent by Professor Call is an immature individual about two-thirds grown, and is in the lead-colored dress so characteristic of the young of this genus. The adults are above the average size of this species, and appear more lightly colored than eastern specimens of *leucopus*, but the skull and feet fix their identity with that species. The male measures 174 mm. in total length, the tail vertebræ 70, and the hind foot 21. The female is longer by 10 mm., owing largely to the greater length of tail, but its feet are of the same length as in the male.

Little Brown Bat. VESPERTILIO LUCIFUGUS Le Conte.

Vespertilio lucifugus Le C. Cuv. An. Kingd., 1831, appx. I, p. 431.
Vespertilio gryphus Fr. Cuv. Nouv. Ann. du Mus., 1832, p. 15.
H. Allen, Mon. Bats N. Amer., Bull. U. S. Nat. Mus., 1893, p. 75.

Geographic distribution. Northern North America, from the Barren Grounds south to the Sonoran and Louisianian regions.

Habitat. Hollow trees, caves, and buildings by day, flying abroad at night in search of food.

Habits. This is, by far, the most common form of bat found in Mammoth Cave—indeed, more than 90 per cent of those I saw appeared to be of this species. In the "Bat Chamber," during the last week in April, there were at least two thousand at one time. They seemed to prefer the higher ledges of the dome, hanging in long, interrupted, single or triple rows, or in other places, covering irregular patches so thickly as to blacken the walls. Among them appeared to be a larger species, which looked like *Adelonycteris fusca*, but no specimens of these have come to hand. In a low, wide passageway (Little Bat Avenue), about one-fourth of a mile from the entrance

to the cave, I found a cluster of little brown bats, which hung like a swarm of bees from a hollow space in the ceiling, just above the level of my head as I stood on the floor. The circular space covered by them was about 18 inches in diameter, and from this were suspended, head downard, nearly 150 bats in a compact, conical mass, several layers deep. How the underlying ones supported the remainder from their apparently insecure attachment to the limestone I could not understand any better than the fact that they were not smothered by the embraces of their uncanny companions.

An exploration of the cave at night failed to show a marked decrease in the numbers of the bats remaining there, although several species were flying abroad at that time, and when we remember that the temperature of the cave remains almost stationary throughout the year, it is not improbable that many of these bats continue torpid for indefinite periods, which have no direct connection with seasonal changes, but are largely dependent on the irregular recurrence of hunger. In this respect cave-dwelling bats must differ greatly from those whose habitat is arboreal, and which are therefore subjected to continual variations of temperature and the consequent activity or repose induced thereby.

Description. This small bat may be known from other of our eastern species by small size, coupled with the dark brown fur and uniformly blackish wings. The tragus is long, pointed and directed backward. The wing membrane extends to the base of the toes. There are two small unicuspid, upper incisors of equal size, separated by a slight diastema from the canine. Just behind the canine is a small premolar, closely followed by a smaller one, and this by the large third premolar and the three molars. Ten specimens from the cave have been critically examined, and are in the Philadelphia Academy's collection. Three of these average as follows: Expanse of wings, 235 mm.; length of body and tail, 83; tail vertebræ, 36; hind foot, 8; height of ear from crown, 11.

Georgia Bat. VESPERUGO CAROLINENSIS Geoff. St. Hil.

Vespertilio carolinensis. Is. Geoff St. Hilaire. Ann. du Mus., 1806, p. 193.

Vespertilio georgianus. Fr. Cuv., Ann. du Mus., 1832, p. 16.

Geographic distribution. Carolinian and Austroriparian regions.

Habitat. Similar to that of the preceding species.

Habits. The Georgia Bat was found only in isolated instances in parts of Mammoth Cave, and never closely associated either with its own species or with the Brown Bat. It was quickly distinguishable from the latter by its much lighter color, and can be recognized by this feature at some distance even by torch light. I found some of this species in small caves in Tennessee, and Dr. H. Allen gives the measurements of one taken in Short Cave, Kentucky, in his recent Monograph.* Dr. Allen there states that "it is often found in collections associated with *Vespertilio gryphus* (*V. lucifugus*), but it is not known to be collected in the same locality with this species," a view which my experience, not only in Kentucky, but in New Jersey also, proves untenable.

Description. Size equal to or greater than *V. lucifugus.* Color tawny or brownish gray, wing membranes blackish, wing bones flesh colored. Anterior upper incisor bifid, larger than second. There is a diastema between upper incisors and canine, the latter closely followed by a rounded conical premolar which touches the large sectorial *pm. 2*, and the latter crowded upon *m. 1*. Only one specimen from the cave is available. It measures in alar extent 225 millimeters; the total length of tail and body is 80, of the tail 35, of the hind foot 8, and of the ear from crown 10.5.

The apparent absence of other species of bats, especially the large Brown Bat, *A. fusca*, and the Red Bat, *A. borealis*, from Mammoth Cave is unaccountable to me, as they abound in the region, and from their habit of roosting in attics and outhouses the cave would seem to present most suitable conditions. The Red Bat, however, is known to hide in trees during the day time in warm weather, and may reside in the cave only in winter.

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*Bull. Nat. Mus., No. 43, 1893, p. 127.

ARTICLE V.—AN ODONATE NYMPH FROM A THERMAL SPRING.

BY D. S. KELLICOTT, COLUMBUS, O.

I received recently, for study, from Dr. Josua Lindahl, four diagon-fly nymphs, obtained by him from Mr. Lloyd T. Stevenson, of Chat, Cal., with the following data (condensed): "Taken August 3d from a hot spring forty three miles west of Reno, Nev., in Lassen County, Cal. The elevation of the spring is about 4,600 feet; it forms a pool forty-five feet long, ten wide, and an average of three deep, and has no outlet. At the western end, where the water issued from the rocks, the temperature was near the boiling point; at the opposite end it was as low as bloodheat. No vegetation was noticed in the hotter part, but in the cooler, certain plants were growing. The water is quite heavily charged with minerals.

"The smaller nymphs were taken in the hottest part of the pool, and the larger one in the cooler part. Ten or twelve nymphs were seen. The smaller ones soon died, as the water in which they were placed when collected cooled."

The presence of animal life in mineral springs of high temperature is a subject of deep interest to biologists, as the ability to withstand such conditions raises many interesting questions. While the references, at hand, regarding plants, mostly algæ, in hot springs are numerous and definite, those made on animals in like situations are few, and among these I have found no allusion to adolescent dragon-flies in such waters.* But the presence of these strictly carnivorous nymphs is of itself evidence that other animals were present, as it would not seem possible for these young to feed on their own kind from start to finish.

Of these larvæ at hand for description one is nearly mature, while three are much smaller, having apparently passed about

*It is regretted that the exact temperature was not ascertained at the time and place of capture of these nymphs Steps will doubtless yet be taken to secure this important fact for different parts of the pool.

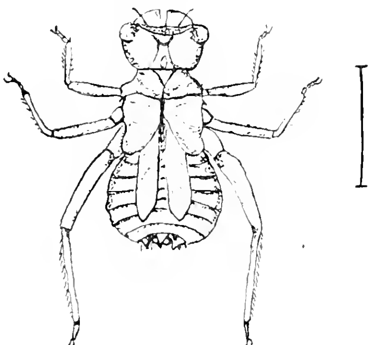
half their moults. The former will be described and figured, and the latter compared as far as may appear necessary for clearness. The seven-jointed antennæ, the three-jointed tarsi, the smooth, opposing edges of the lateral lobes of the labium, and the relatively short abdomen place this nymph, without question, among those of the Family Libellulidæ.

The size is as follows: Total length, 15 mm.; of the abdomen, 7 mm.; width of abdomen, 6.5 mm.; of the head, 5 mm.; length of wing covers 7 mm.; of the extended labium, 7 mm. The general color is slightly olivaceous above, more or less mottled; beneath whitish.

The head, seen from above, is subquadrangular; vertex and posterior lateral angles rounded; frons concave between the rather small, round eyes, and slightly convex at the union with the clypeus; labium whitish; the opposing edges of the lateral lobes smooth-bearing, chestnut setæ; antennæ pale; joints 3, 6, and 7 are nearly equal, and as long as 1 and 2 together; 4 and 5 are shorter; the covered-mouth parts are villous.

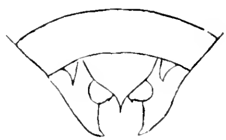
The front of the prothorax is vertical, and has a sulcus parallel to its upper margin; the latter is quite deeply bilobed. The legs are obscurely ringed, with darker shades.

The lateral margins of the abdomen are strongly produced; there are no dorsal hooks or lateral marginal spines; the tenth ring is very short, 3 to 9 longer and equal. The abdominal appendages are about the length of 9 and 10; the superior middle one is shorter than the lower laterals, broad at base,



W.E.K. del.

Fig. 1.



W.E.K. del.

Fig. 2.

and ends in a stout spine; the superior laterals are shorter—seen from above, they are spine-like, with spinous apex discurved; the lower laterals are broad, with stout, decurved apex; margins convex with rows of brown setæ. The wing-covers reach the ninth abdominal ring.

The smaller specimens are much lighter in color and measure 7 mm. in length; the wing-covers are very rudimentary; There are no other notable differences.

Figure 1 was drawn from the mature individual; Figure 2 from the tip of the abdomen of a small one; it shows the parts flattened by the compressorium, and the lateral appendages, more or less nearly from the side.

The type specimens are preserved in the Museum of the Cincinnati Society of Natural History, being entered in the Accession Catalogue as Nos. 9315 and 9316.—*J. L.*

ARTICLE VI.—CATALOGUE OF THE ODONATA OF OHIO.

Part III.

By D. S. Kellicott, Columbus, O.

The former parts of the catalogue* contained the names of eighty-six species. During the season of 1896 several additions have been made to our known species, and this Part III is published to extend the list and to correct certain errors of identification in the preceding parts. The species, No. 86, which was referred, with doubt, to *Diplax madida* Hagen, proves not to be that insect and the name should be erased. Concerning the proposed variety, *Gomphus fraternus* variety *walshii*, it may be said that a more complete series of *fraternus* has been obtained, and it does not longer seem best to continue the varietal name. It is, therefore, withdrawn and *G. lividus*, taken in 1895, but not hitherto identified, given its place, as follows:

77. *Gomphus lividus* Selys.

One male taken at Sugar Grove, May 18, 1895. The one captured was resting with others in a roadway at a long distance from permanent water.

The additions of 1896 are nine in number and are as follows:

(2) Agrioninæ.

86. *Enallagma aspersum* Hagen.

Examples of this pretty and abundant species were first taken by my associate, Jas. S. Hine, at Minerva Park, near Westerville, May 4th. It was abundant at Sandusky, July 30th, and at Wauseon, August 6th (Hine); one male was taken at Minerva Park, October 10th.

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*Journal Cin. Soc. of Nat. Hist., Vols. XVII, p. 195, and XVIII, p, 105.

87. *Enallagma doubledayi* Selys.

Two males were captured by Mr. Hine at Minerva Park, May 4th. It has not been seen elsewhere in the State. The discovery of *doubledayi* in Central Ohio was quite unexpected, as it has not been reported previously from the interior. W. F. Kirby, in his Catalogue of the Odonata of the World, gives its habitat Florida and Cuba. Philip P. Calvert has reported it from one of the Elizabeth Islands.

(3) GOMPHINÆ.

88. *Ophiogomphus rupinsulensis* Walsh.

The first capture, a teneral male, was made by Mr. C. B. Steward on the State University Campus, May 5th. From the middle of May until the middle of June it was common, in company with *G. fraternus* and *G. externus*, flying above the swiftest water of the Olentangy River at Columbus or resting on its gravelly banks, near rapids.

89. *Gomphus quadricolor* Walsh.

One female was taken May 20th by Mr. Ernest Scott on the grounds of the State University. Two males were subsequently captured by the writer at Columbus. One was resting on a rock jutting out of swift water and one on the bank near by. It is an elegant and, apparently, not very active species.

90. *Gomphus notatus* Rambr.

Teneral males and females were taken at Sandusky, June 20th. It occurred about the sand dunes on Cedar Point (Sandusky), resting on coarse grasses, through July. None were seen ovipositing or flying, except to escape from danger. Nymphs crawled up piles and walls in the harbor for their final change, which shows that they inhabited water of considerable depth.

91. *Gomphus* Sp.

One female taken by Jas. S. Hine at Wauseon, July 1st. It appears to belong to the same group as *G. notatus*, but dif-

fers from that species in coloration, form of the vulvar lamina, and in proportion of length of the abdomen and hind wing; it differs from *spiniceps* notably in having segments 8 and 9 equal. Length of abdomen, 42 mm.; of hind wing, 38 mm.

(7) LIBELLULINÆ.

92. *Tramea onusta* Hagen.

Three males were taken in Minerva Park, May 7th. There is no apparent difference between these and those sent by Professor E. E. Bogue from Oklahoma.

Onusta is the third species added to our list from an artificial lake in Minerva Park the first week in May. This lake had existed only since July, 1895; previously a mere rivulet flowed through the valley; this was dammed, and the rivulet and water pumped from Alum Creek, a mile away, filled the lake. Except the creek mentioned, there were no other permanent bodies of water near. Various species of Odonates swarmed about the park in May. Their larvæ could hardly have been carried in by the pumped stream, and it seems a fair inference that most of these nymphs matured in the lake, and that they require but one season to reach maturity.

93. *Libellula axillena* (form *incesta*) Hagen.

It was first taken by R. C. Osburn and E. B. Williamson at Sandusky, June 26th. The males were among the most abundant Libellulas during July around the marshes of the bay; the females, on the contrary, were rarely seen. The behavior of this form and *vibrans* is quite different; the males of the latter fly very little about the bordering herbage in search of the females; instead they sit for long periods on some dry twig or projecting stick awaiting the approach to water of the females for oviposition. On the contrary, the males of *incesta* patrol the marshes with strong and constant flight. The females of both forms rest most of the time at a distance from the water in the lea of some suitable shelter; they repair at intervals to the water in order to oviposit, and then return to their perch.

94. *Celithemis elisa* Hagen.

The first captures were by E. B. Williamson and R. C. Osburn at Sandusky, June 26th. This fine insect was common around the marshes until the end of July. Taken by Mr. Hine at Wauseon in August.

Elisa in flight and habits very much resembles *C. eponina*. It appears, however, to be the butt of odonate society for *Anax*, *Libellula*, and *C. eponina* are sure to pay it their disrespects whenever they spy it in passing; they are sure to make a dive for it and, as it appears, tear its gauzy wings; for it was not uncommon to see the males, otherwise in good condition, with the hind wings shredded.

NOTES.

1. The season of 1896 was somewhat at variance with that usual in Ohio. The temperature remained constantly low until April 10th, when summer conditions came suddenly and continued almost without interruption until the usual time of summer heat. In consequence several species appeared weeks earlier than usual. At Columbus ten species were taken in April and nearly forty in May. Five is the highest number recorded for April in any previous year.

2. A dearth of Odonates was looked for this year on account of the prolonged drouths of 1894 and 1895. Such was not the case; on the contrary, both species and individuals were abundant everywhere that observations have been made. It seems to follow that the nymphs somehow are able to survive severe drought. Again, in more than one instance, species of *Diplax* were seen industriously ovipositing among the grass growing in the bed of a pond from which the water had long since disappeared. Perhaps eggs thus cast away may remain uninjured until the return of water.

3. It is well known that when the females of some species are held with the wings back to back they soon begin rapidly to extrude their eggs; this seems to be an instinctive effort to prevent their destruction, and doubtless often succeeds, for the eggs are undoubtedly fertilized and when they happen to fall into the water are saved.

4. Cases of heterogeneous copulation have been recorded in previous numbers of the catalogue; the following may be added: *Lestes disjuncta* ♂ with *Lestes vigilax* ♀ and *Basiæschna janata* ♂ with *Tetragoneuria cynosura* ♀.

5. *Lestes forcipata* was flying in abundance at Columbus, April 24th. *Lestes vigilax* was exceedingly numerous from June to August in the marshes of Sandusky bay.

6. *Anomalagrion hastatum* has been observed this year as follows: Columbus, from April 24th to September; Wauseon, June 20th to August 10th; Sandusky, through July; Georgesville, September 2d. It, therefore, occurs throughout the State and is one of the earliest to appear, remaining until late.

7. *Gomphus externus* Selys (*G. consobrinus* Walsh). Many males and three females were taken along the Olentangy River at Columbus in May and June. Its habits are similar to those of *fraternus* with which it usually flies. The female has the occiput straight, not "rising in the middle in two confluent curves" (Walsh), nor is "the space between the lateral thoracic lines livid," but of the more usual greenish yellow hue; the vertical thorns are black and conical; the posterior femora are either with or without external vittæ, in this regard agreeing with the female of *fraternus*. It has been said that the latter has no vertical thorns, and that the females of *externus* and *fraternus* may thus be separated; this will not do, for the female *fraternus* has long slender, black or yellow vertical thorns; they are easily separated, however, by the differences in the occiput—*fraternus* with a spine in the middle of the border, *externus* having the same straight or slightly concave—*externus* is larger and the vitta on ♀ is almost as conspicuous as in *externus* male.

8. *Dromogomphus spoliatus*, hitherto rare, has this year, been taken at Napoleon by Mr. Jas. S. Hine; he found it abundant along the Miami Canal.

9. Mr. Hine captured one male of *Macromia tæniolata* at Napoleon.

10. Mr. E. B. Williams took *Pantala hymenæa* at Loramie Reservoir.

11. *Diplax corrupta* was abundant through July and August at Wanseon and Sandusky. It has been taken in numbers as far east as Buffalo, N. Y., by Mr. E. V. Van Duzee.

The table, commenced in Part II, giving a connected view of the present recorded distribution and the time of occurrence, may be corrected and continued as follows:

Cat. No.	NAME.	North. Ohio.	Cent'l Ohio.	South. Ohio.	Early Sum.	Mid Sum.	Late Sum.
7	L. forcipata...	×	×	....	×	×	......
86	E. aspersum .	×	×	....	×	×	×
87	E. doubledayi.	....	×	....	×	......	......
74	A. hastatum ..	×	×	×	×	×	×
88	O. rupinsulensis	....	×	....	×	......	......
89	G. quadricolor	....	×	....	×	......	......
77	G. lividus.....	....	×	....	×	......	......
90	G. notatus....	×	....	....	......	×	......
91	Gomphus sp..	×	....	....	×	......	......
83	P. hymenæa..	....	×	×	......	×	......
92	T. onusta.....	....	×	....	×	......	......
93	L. incesta	×	....	....	......	×	......
94	C. elisa.......	×	....	....	......	×	......

ARTICLE VII.—ON THE PULSATIONS OF THE MOLLUSCAN HEART.

BY FRANK C. BAKER, B. S., CHICAGO, ILLINOIS.

While dissecting snails for the radula, etc., my attention was attracted by the pulsations of the heart, seen through the thin shell, and the thought occurred to me to study this organ and record my observations. The following notes are the result of such study.

Before entering upon a detailed account of the pulsations of the heart, it might be well to explain the position and character of the molluscan heart. For the better understanding of the matter, we will divide the subject into two parts—I. *Pelecypoda*; II. *Gastropoda*.

I. PELECYPODA.

The heart is an oval, transparent body and consists of a central ventricle and two lateral auricles, contained in the cavity of the pericardium. The ventricle gives rise to a dorsal anterior aörta and a ventral posterior aorta, which lie above and below the intestine, the latter running longitudinally through the ventricle. The auricles receive the blood from the bases of the gills and drive it into the ventricle, from which it is driven through the arteries into spaces which diminish into irregular lacunæ as they reach the viscera. The general course of the circulation is as follows: From the ventricle the blood makes its way by the large veins into a venous sinus, which is a long chamber lying on the middle line of the floor of the pericardium, into which it opens by a single median aperture near the anterior end; on either side of the venous sinus lie the renal organs (organs of Bojanus or nephridia); the blood passes from the venous sinus, through the glandular walls of the renal organs, right and left, into the lamellæ of

the gills, and then through the bases of the gills into the auricles. The ventricle is supplied with lip-like valves, which prevent the blood from returning to the auricles. The blocd corpuscles are colorless, and are amœboid in shape.

II. Gastropoda.

The circulatory system varies to some extent in the land and fresh-water forms, but is essentially as follows: The blood passes from the cavity of the foot into the opening of a large vein, and from other minor veins into this vein, and then passes into the branchial vein, and finally into the ventricle, and out of this into the arteries, to be again distributed over the body. There is a single ventricle and one or two auricles. When the latter is the case they surround the rectum, as in the Pelecypoda. In the Pulmonata the single auricle lies always in front of the ventricle, and the blood flows backward to the heart from the forepart of the animal. In the Opisthobranchiata this order is reversed. In the land shells the heart is situated on the left side of the animal, between the liver and the kidney, and below the apex of the respiratory cavity, or "lung."

In recording the pulsations of the Pelecypoda, the writer extracted the animal from its shell by cutting the adductor muscles near their attachment to the shell, thus separating it from the animal without damaging the latter. When removed the pericardium could be plainly seen, near the umbones, and the heart to contract and expand. The contractions and expansions appeared to be wave-like, causing the cavity of the pericardium to swell out considerably. In the Pulmonata the heart could be plainly seen just at the periphery (sometimes above it) and to the left of the aperture. The pulsations were always from right to left, and the auricle seemed to push the ventricle backward at every pulsation. When the shell is wet the observations are easier to make, the shell being more transparent in this condition. The pulsations are visibly affected by heat and cold and by excitement. During the hibernating season the pulse is much slower than at other times—in fact it nearly ceases.

Register of Observations.

Anodonta grandis Say. A half dozen individuals of this species were examined with some curious results. The first two specimens had what appeared to be double pulsation, which consisted first of a short, quick pulsation, followed immediately by a long, slow pulsation. Thirteen long and thirteen short throbs were counted, making a total of twenty-six pulsations to the minute. In the other four individuals fifteen regular beats were counted, and this is probably the normal pulse. It is quite likely that the specimens first examined were injured in being removed from the shell.

Anodonta edentula Say. A number of specimens of this species have been examined, and the records are very constant. The pulsations were very regular, numbering ten to eleven per minute. In this species the heart could be seen beating for nearly half an hour after animal was removed from the shell.

Anodonta lacustris Lea. The heart pulsations of this species are unusually regular. In a number of specimens examined the variation was but a single point, and that only in one specimen. The record gave 29–30 beats per minute, 29 being the specimen which was below the normal. The number of pulsations is large for the genus.

Anodonta ferussaciana Lea. Pulsations 16 per minute, with no variation. All examinations made showed a wonderful degree of constancy.

Margaritana rugosa Barnes. This species is very slow and sluggish in its circulation. The pulsations were regular and slow, 13 per minute.

Unio luteolus Lam. The movements of the heart may be seen very plainly through the transparent walls of the pericardium. The contractions in this species are particularly wave-like. The pulsations are regular and number 16 per minute.

Unio gibbosus Barnes. The pulsations number 20 per minute. Very regular.

Unio undulatus Barnes. Pulsations regular, 11 per minute.

Unio iris Lea. Sometimes a double pulsation, a long one followed by a short one; 14 per minute.

Unio lachrymosus Lea. Heart very active and regular; pulsations 31 to 33 per minute.

Unio pustulosus Lea. Pulsations regular, 23 per minute.

Unio ventricosus Barnes. Pulsations regular, 17 to 18 per minute.

Unio parvus Barnes. Pulsations regular, 36 per minute. This is the largest number recorded for the genus *Unio.*

Unio spatulatus Lea. Pulsations regular, 16 per minute.

Sphærium stamineum Conrad. Pulsations regular, 57 per minute. This number is unusually high for a pelecypod, but the animal is very active, which accounts for the high rate of pulse.

Selenites concavus Say. The heart is situated 5 mm. from the edge of the aperture, and is plainly seen through the transparent shell, especially if it be moistened. The pulsations are very regular, but vary in number, being more numerous when the animal is stretched out as during locomotion, and few when the animal is contracted. From twenty observations the following data are taken, ranging from the lowest to the highest number: 50, 56, 72, 75, 78, 82. Temperature affects the heart's action, cold causing it to cease beating apparently, and heat causing it to beat very rapidly; 50 is the normal when contracted and 82 when extended and active.

Vitrea arborea Say. Pulsations rapid and regular, varying from 100 (contracted) to 160 (expanded) per minute.

Vitrea nitida Müller. Pulsations varying from 101 to 138.

Vitrea cellaria Müller. The pulsations are regular when the animal is extended, but seem to be irregular and interrupted when the animal is contracted. The pulse varies from 46 to 84. When contracted the beats may be represented by the following diagram, in which the dot represents the period of rest between the beats, and the dash the length of the beat:

— . —— . — . ——— — . — . — . — . —— . —— . —— .

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Vitrea electrina Gould. Pulsations regular, varying from 95, when contracted, to 130 when extended.

Vitrea indentata Say. The pulsations in this species seem to be always high, the writer being able to record only 160 to 162 beats per minute.

Conulus fulvus Drap. Pulsations very rapid, and 148 to 150 per minute, regular. The heart is situated near the umbilicus.

Pyramidula alternata Say. The heart is situated 3 mm. from the junction of the peristome with the body whorl, and the pulsations are very regular. Fifteen experiments gave the following record of pulsations: 84, 82 (13 specimens gave these results, the animal being fully extended), 61, 50. The last two were from specimens contracted.

Pyramidula striatella Anthony. Heart situated as in *Vitrea arborea*, pulsations regular, and number 87 to 90 per minute.

Polygyra profunda Say. The heart in this species is plainly seen just below the largest brown band, and about 5 mm. from the aperture. An examination of a dozen specimens gave the following data: 70 (3 specimens), 65 (4 specimens), 62 (3 specimens), 58 (1 specimen), and 56 (1 specimen). When the animal was held tightly in the hand the record was 56–58; when the animal was extended the record was 65–70.

Polygyra thyroides Say. Heart situated near the upper part of the peristome with the body-whorl; pulsation irregular (70–73) when contracted, regular (82) when extended.

Polygyra monodon fraterna Say. Pulsations regular, 98–100 per minute. Heart situated as in *leaii*.

Polygyra leaii Ward. Heart situated between the tooth on the parietal wall and the junction of the upper part of the peristome with the body-wall, pulsations varying from 71 to 76 per minute (animal extended).

Polygyra hirsuta Say. Heart situated to the left of the center of the parietal tooth; pulsations regular, 60 per minute (extended).

Polygyra clausa Say. Heart situated on a direct line, midway between umbilicus and junction of upper part of peristom with body-whorl; pulsations regular, 88 per minute (extended).

Polygyra pennsylvanica Green. Heart situated near junction of peristome with body-wall; pulsations regular, 85 (extended).

Succinea obliqua Say. Heart situated midway between anterior and posterior border of aperture; pulsations regular 69 per minute (extended).

Succinea ovalis Gould. Heart situated as in *obliqua;* pulsation 150 to 155 per minute (extended).

Succinea avara Say. Heart situated as in the two last species: pulsations regular, 130 per minute (extended).

Limnæa desidiosa Say. Heart situated near the umbilicus; pulsations quick and regular, 155 per minute (animal active).

Limnæa columella Say. Heart as in *desidiosa;* pulsations somewhat irregular, three or four being quick, followed by a pause; 53 to 60 per minute (animal active).

Limnæa palustris Müller. Heart situated about two-thirds of the distance from the lower border of aperture, between upper and lower margins of aperture: pulsations regular, 81 per minute (animal active).

Limnæa caperata Say. Heart as in *desidiosa;* pulsations irregular, varying from 129 to 133 per minute (animal active).

Limnæa stagnalis Linné. Heart as in *desidiosa;* pulsations irregular, varying from 37 to 48 per minute (animal active).

In the foregoing experiments 39 species have been examined and several hundred specimens. The results are somewhat curious. In some species there is a wonderful degree of constancy in the number of the beats, while in others they seem to be quite erratic. One law applies equally to all, that the more active the species the larger the number of pulsations; and also with the same species, when in a contracted condition the pulsations are fewer and more feeble than when extended and active. The pelecypods are all sluggish, and have a corresponding low pulse, while the majority of the gastropods are active and have a high rate of pulse. The average pulse of the Pelecypoda is 22 beats per minute, the lowest record being 10 and the highest 36 (an exception is found in *Sphærium stamineum*, which has a record of 57 to the minute). In the Gastropoda the average is 98, the lowest 50, and the highest 162. It is quite probable that during the hibernating season the pulsations are reduced almost to nothing, in order not to use up the vital force of the animal The writer has been unable to detect any movement of the heart when the mollusk is in this condition.

NOTE ON THE FLORA OF MAMMOTH CAVE, KENTUCKY.

BY R. ELLSWORTH CALL, PH. D.

Very little is known of the plants which occur in this underground world, the animals hitherto having been chiefly gathered and studied. During frequent visits for study of the cave and its fauna, opportunities were presented to me to make some casual notes on its flora, and these are here given in condensed form.

The plants are, of course, all cryptogams, and mostly microscopic. The molds and mildews are most commonly observed growing on the rejectamenta of lunches taken into the cave by visiting parties. Even with these forms, introduced thus and forming no part of a true subterranean flora, the list is a meager one. The list following contains all that have been noticed thus far.

Coprinus micaceous Bull.—Groups of this form have been taken only in River Hall, near the Cascades, and at the boat landing.

Fomes applanatus Pers.—In the Labyrinth. Attached to timbers used in bridge construction, and probably introduced on them. The forms, are, however, curiously modified, being cylindrical in shape aud curiously contorted.

Rhizomorpha molinaris.—Abundant on old timbers in Mammoth Dome. This form is common on old timbers in mines; some foreign representatives are phosphorescent.

Microascus longirostis Zukal.—Washington Hall.

Zasmidium cellare Fr.—Top of Corkscrew. On old barrel head. Probably introduced with the barrel.

Mucor mucedo Linnæus. Abundant in the labyrinth and on the bridge over the Bottomless Pit. Also observed at Mary's Vineyard and in River Hall.

Gymnoascus setosus Eidam.—Washington Hall.

Sporotrichum densum Link.—On dead bodies of crickets (*Hadenœcus subterraneus*).

Sporotrichum flavissimum Link.—Washington Hall. On old bones and refuse of lunches.

Laboulbenia subterranea.—Found as a parasite on the little beetle, *Anophthalmus tellkampfii.*

Carmansia sp. undt.—Washington Hall.
Papulospora sp. undt.—Washington Hall.
Bouderia sp. undt.—Washington Hall.

Several of these forms occur in the greatest abundance in certain portions of the cave, the region beyond the rivers being the favored localities, because, probably, many spores are introduced with the lunches, and find congenial homes and abundant nourishment on the refuse. Mention should also be made of a small *Peziza*, which occurs on very old, water-soaked timbers in the Mammoth Dome. It still persists in presenting reddish coloration, notwithstanding that the forms at present found must represent a generation quite remote from the one originally introduced. The constant temperature of the cave (54° F.) is somewhat below that for the abundant production of most forms of lower fungi.

Of the forms which are here mentioned *Coprinus micaceous*, *Rhizomorpha molinaris*, and *Mucor mucedo* are probably subterranean. With the exception of the first, all are common to mines, and apparently grow in them under practically the same conditions as those which obtain in Mammoth Cave.

Most of the forms are variously modified, if one might judge from the published descriptions, due, no doubt, to the changed environment. Certain forms, like the *Sporotrichia*, are sarcophytic. In damp localities in the cave these forms always are to be found on the bodies of dead crickets. Their more proper reference, possibly, would be to the genus *Isaria*.

In certain localities the great white patches of *Mucor mucedo* are conspicuous both from their size and their great delicacy. Over the Bottomless Pit this fungus hangs down in long festoons of a feathery-white, cottony consistency, giving a most uncanny appearance to the half-decayed woodwork. In other places it runs wild over the soil surrounding decaying timbers—a very cloak of snowy whiteness. These two last named forms are the most conspicuous in the wastes of the cave, but are often passed by, mistaken for sheets of paper or balls of the same substance.

Very little new is added in this brief note, but enough to disclose to botanists who may read it that much yet remains to be done in the underground regions of America. Characteristic plants are certain yet to be found.

ARTICLE IX.—NOTES ON RADULÆ.

BY FRANK COLLINS BAKER, CHICAGO, ILLINOIS.

While preparing a report on the mollusks of the Chicago area, the writer examined the radulæ of many hundred specimens, and figured and described many ribbons which were before unknown or but little known. It has been thought best, since the work just mentioned will be delayed some time before publication, that the new radulæ, as well as notes upon others already known, be described and figured at the present time.

The radulæ were all examined from fresh material, not alcoholic, the animals being killed by boiling water. The lingual ribbons were beautifully clear and transparent, and when stained with a 4 per cent solution of iodine the characters could be very plainly seen, the cusps standing out in relief against the base of attachment. The objective used gave 600 diameters for most of the radulæ. The drawings were all made several times, and from several individuals, in order to be sure of each fact.

While observing the living snails in an aquarium the writer has been impressed by the curious manner in which *Limnæa*, *Planorbis*, *Pleurocera*, *Campeloma*, etc., eat; the motion of the tongue is precisely that of a cat lapping milk, although the motion is not quite so rapid as in the latter animal. Land shells, on the contrary, seem to use the jaw for cutting a piece of lettuce (the article of food which the writer uses for snails in captivity), and the ribbon is pressed against the jaw and assists in cutting the lower part of the piece selected. In the fresh-water forms it is the ribbon and not the jaw (or jaws) which collects the food. This, of course, refers only to those species which habitually crawl over the glass sides of an aquarium (or over stones on the bottom) and not to the individuals which eat the leaves of aquatic plants, for they may use their jaws, as do the land snails.

Pupa contracta Say. Plate IV, A.

Jaw long and narrow, slightly arched, the ends a little narrower than the central part and rounded; convex margin smooth, concave margin notched, and anterior surface vertically striated (Fig. A, 10).

Radula formula $\frac{7}{3-7}+\frac{4}{2}+\frac{1}{3}+\frac{4}{2}+\frac{7}{3-7}$ (11 – 1 – 11); central tooth with a base of attachment longer than wide, and with the lower outer angles expanded; reflextion small, narrow, tricuspid; the central cusp rather long, wide, and blunt, the side cusps shorter and sharper; lateral teeth with a wide base of attachment, expanded on the lower outer angle, the reflection narrow and bicuspid, the inner cusp very long and wide, almost reaching the lower margin of the base of attachment, the outer cusp about half as long and rather sharply pointed; marginal teeth low, wide, with from 3 to 7 cusps, the inner cusp being very large and sharply pointed, the others very short. The fifth marginal has 3 cusps, the seventh 5 cusps, and the ninth 7 cusps; all of the cusps have well-developed cutting points. Several specimens have been examined, and all agree with the above description (Fig. A).

Limnophysa columella Say. Plate IV, I.

Jaws three, the median (superior) elliptical, smooth, or only slightly striated, the lateral jaws irregular, finely striated; cutting-edges brownish black, shading into yellowish black toward the base of the cartilage (Fig. I).

Radula formula $\frac{25}{4}+\frac{1}{3}+\frac{9}{2}+\frac{1}{1}+\frac{9}{2}+\frac{1}{3}+\frac{25}{4}$ (35 – 1 – 35); central tooth very small, long, and narrow, the lower outer corners of the base of attachment very much attenuated; reflexion unicuspid, bluntly rounded; lateral teeth with a quadrate base of attachment, the outer lower corner expanded; reflexion long and rather wide, reaching below the base of attachment, bicuspid, the inner cusp very large and long, the outer cusps small and sharp; the inner cusp has a peculiar shape, which is an indication of the third cusp of the transition teeth; the tenth tooth is tricuspid, and is a transition between the lateral and marginal teeth; marginal teeth longer than wide, generally four-cuspid, the inner cusp placed

about midway of the reflexion, the other then placed at the distal end; there are generally several small denticles on the upper inner edge of the reflexion; the outer marginal have all the cusps placed at the distal end, and the margins are simple. The marginals vary greatly in the form and position of the cusps. All have decided cutting points. A number of specimens examined.

LIMNOPHYSA DESIDIOSA Say. Plate IV, C.

Radula formula $\frac{30}{4}+\frac{9}{3}+\frac{7}{2}+\frac{1}{1}+\frac{7}{2}+\frac{9}{3}+\frac{30}{4}$ (46–1–46); teeth similar to those of *L. columella;* the marginal teeth are very variable; 1 to 7 are perfect laterals, bicuspid, 8 to 16 are transition teeth, tricuspid, with a large central cusp and two small side cusps, one on each side; the marginals are at first modified transition teeth (17 to 20, but soon the tooth becomes long and narrow and the distal end becomes 3–4 cuspid and has several small denticles on the outer central margin of the reflexion (21–34); the outer marginals (35–46) are denticulated only at the distal ends. A number of specimens have been examined.

LIMNOPHYSA HUMILIS Say.

Radula formula $\frac{12}{4}+\frac{4}{3}+\frac{6}{2}+\frac{1}{1}+\frac{6}{2}+\frac{4}{3}+\frac{12}{4}$ (22–1–22); teeth in all respects similar to those described above.

LIMNOPHYSA CAPERATA Say. Plate IV, B.

Radula formula $\frac{23}{4}+\frac{2}{3}+\frac{7}{2}+\frac{1}{1}+\frac{7}{2}+\frac{2}{3}+\frac{23}{4}$ (32–1–32); teeth as usual; the 8–10 teeth are transitory and the 11 to 32 are all of the usual form of marginals; several teeth had the distal end broken up into two large cusps and several small cusps (14). A number of specimens were examined.

LIMNÆA CUBENSIS Pfeiffer.

Radula formula $\frac{23}{5}+\frac{2}{4}+\frac{1}{3}+\frac{4}{2}+\frac{1}{1}+\frac{4}{2}+\frac{1}{3}+\frac{2}{4}+\frac{23}{5}$ (30–1–30); teeth as usual; the first four laterals are bifid, the next is trifid; 5 to 7 are transitory and 8–30 are of the usual form of

marginal. The dentition is very similar to that of *L. caperata*. A large number of specimen have been examined.

Limnophysa palustris Müller. Plate IV, D.

Radula formula $\frac{21}{4} + \frac{4}{3} + \frac{9}{2} + \frac{1}{1} + \frac{9}{2} + \frac{4}{3} + \frac{21}{4}$ (34–1–34); teeth as usual; laterals bicuspid; transition teeth at first like laterals, but tricuspid, the central cusp the largest (11), but soon (13) the inner cusps become more equal and the outer cusp smaller; marginal teeth of the usual type. A single membrane (D) had the first lateral to the right of the central tooth with a bifid outer cusp. This was observed in all the first laterals of this membrane.

Limnophysa palustris michiganensis Bryant Walker.

Radula not differing from the typical form.

Limnophysa reflexa Say.

Radula formula $\frac{24}{4} + \frac{6}{3} + \frac{10}{2} + \frac{1}{1} + \frac{10}{2} + \frac{6}{3} + \frac{24}{4}$ (40–1–40); teeth similar to those of *palustris*; there is very little variation in the form of the teeth in this species.

Limnophysa reflexa attenuata Say.

Radula not essentially differing from typical *reflexa*.

Limnæa stagnalis Linné.

Radula formula $\frac{19}{4} + \frac{4}{2-3} + \frac{13}{2} + \frac{1}{1} + \frac{13}{2} + \frac{4}{2-3} + \frac{19}{4}$ (46–1–46); teeth as usual. The writer has examined several membranes of this species and the number of teeth vary from 46–1–46 to 54–1–54. Binney (L. & Fr. W. Shells, p. 28) gives 40–1–40 and (p. 155) 47–1–47 teeth; Bland and Binney (Amer. Journ. Conch, Vol. VIII, p. 161) give 40–1–40. It is probable that the membrane having 54–1–54 teeth was abnormal. 46–1–46 is the number generally found.

Helisoma trivolvis Say. Plate IV, E.

Radula formula $\frac{12}{3+7}\quad\frac{7}{3}\quad\frac{1}{2}\quad\frac{7}{3}\quad\frac{12}{3+7}$ (19–1–19); central tooth with a base of attachment longer than wide, swollen and rounded on the lower half, reflexion broad, bicuspid, the cusps long and narrow, fang-like; lateral teeth with a quadrate base of attachment and a large, square reflexion which is tricuspid, the center cusp being very wide and blunt and the side cusps long and narrow and directed outward; intermediate teeth similar to laterals, but varying in the number and arrangement of the cusps; sometimes the change from laterals to marginals is abrupt, at others it is very gradual, and in some membranes there appear to be no two marginals alike; the large, blunt central cusp in the lateral teeth becomes a long and narrow cusp in the intermediate (transition) teeth and the side cusps become much larger, so that all three cusps are about equal; in addition to this, the outer edge of the outer cusp develops several small denticles; marginal teeth long and narrow, with three small cusps at the distal end and several (3–4) small denticles on the outer edge. A number of specimens have been examined.

Helisoma truncatus Say.

But a single specimen of this species has been examined and did not seem to differ from *H. trivolvis*. The formula was $\frac{12}{5+} + \frac{3}{3} + \frac{7}{3} + \frac{1}{2} + \frac{7}{3} + \frac{3}{3} + \frac{12}{5+}$ (22 – 1 – 22). The specimen examined was a large example, characterized by the lattice-like sculpture peculiar to this species.

Helisoma bicarinatus Say. Plate IV, F.

Radula formula $\frac{21}{5+} + \frac{3}{3} + \frac{6}{3} + \frac{1}{2} + \frac{6}{3} + \frac{21}{5+}$ (30 – 1 – 30); central tooth as usual; lateral teeth of usual shape, but reflexion with a large squarish central cusp, a large rounded inner cusp and a smaller outer cusp; transition teeth (9) with three nearly equal, rather sharp cusps; marginal teeth, as in *trivolvis*. The writer counted 136 rows of teeth.

Helisoma campanulatus Say. Plate IV, G.

Radula formula $\frac{15}{5+} + \frac{3}{3} + \frac{7}{3} + \frac{1}{2} + \frac{7}{3} + \frac{3}{3} + \frac{15}{5+}$ (25 – 1 – 25); central tooth as usual; lateral teeth with three very nearly equal cusps, the central cusp being a little longer than the others; transition teeth and marginal teeth as usual. The lateral teeth of this species differ considerably from those of *trivolvis*, *bicarinatus*, and *truncatus*, in having three nearly equal cusps. Several examinations have been made to verify this statement.

Gyraulus parvus Say. Plate IV, J.

Radula formula $\frac{10}{4-6} + \frac{8}{3} + \frac{1}{2} + \frac{8}{3} + \frac{10}{4-6}$ (18–1–18); central tooth with a base of attachment longer than wide, produced at the lower outer corners, and excavated in the center of the lower margin; reflexion bicuspid, the cusps short and wide; lateral teeth with a subquadrate base of attachment, expanded at the lower outer corner, reflexion wide, tricuspid, the central cusp long and rather wide, the side cusp shorter; marginal teeth modified laterals in being low and very wide, the outer cusp splitting into 2–3–4 small cusps. A number of specimens have been examined, and there appears to be no variation worthy of mention.

Segmentina armigera Say. Plate V, A.

Radula formula $\frac{9}{4+} + \frac{9}{3} + \frac{1}{2} + \frac{9}{3} + \frac{9}{4+}$ (18–1–18); central tooth with a long, narrow base of attachment, expanded on the lower outer corners; reflexion wide, bicuspid; lateral teeth wide, a trifle longer than wide, tricuspid, the center cusp long, wide and sharp, and the side cusps short and sharp; marginal teeth at first similar to laterals, with the addition of a second, small outer cusp, but becoming wide and low toward the margin, and developing three small outer cusps. A large number of specimens have been examined.

Ancylus rivularis Say. Plate V, B.

Radula formula $\frac{11}{3\ 4\text{-}5} + \frac{5}{3\ 2} + \frac{1}{1} + \frac{5}{3\ 2} + \frac{11}{3\ 4\text{-}5}$ (16–1–16); the central tooth is simple, as in *Limnæa;* the lateral teeth have a

base of attachment longer than wide, the lower outer angle expanded; the reflexion is very broad and bicuspid, the inner cusp being very large and semi-bifid, and the inner cusp is small and narrow, and there are two very small denticles on the edge of the upper part of the outer cusp; the fifth lateral is somewhat narrower, and the inner cusp is split to form a large central cusp, with a small side cusp on each side; the marginal teeth are very narrow, with a long, narrow reflexion, which is distally tricuspid, the central cusp being the larger; the outer edge of the reflexion is serrated by about five small denticles. The bifurcation of the inner cusp of the lateral teeth is difficult to see, but it has been distinctly observed on a number of teeth. The cutting points are very well developed, but are also difficult to see clearly. Ninety rows of teeth were counted, and in one individual 20–1–20 teeth were found.

ANCYLUS TARDUS Say.

The radula of this species does not seem to differ essentially from that of *A. rivularis.*

PHYSA HETEROSTROPHA Say. Plate V, C.

Jaw in one piece, arched, striated, provided with a central fibrous projection from the superior surface; ends rounded (C, c).

Radula formula $\frac{9.5}{13} + \frac{9.5}{1} + \frac{1}{2\text{-}5\text{-}2} + \frac{9.5}{1} + \frac{9.5}{13}$ (190–1–190); central tooth more or less quadrate, the lower outer corners being very much attenuated; cusp attached at base, 9-quadrate, five dentals being long and narrow, and two on each side small and blunt; laterals on two alternate series, the first or primary teeth being large, obliquely inclined, comb-like, and 13-dentate, six denticles being long and pointed and seven short and wide. The secondary teeth are long and narrow, with a blunt cusp. These latter are very difficult to see, on account of their small size; the central teeth are also difficult to make out. Mr. W. H. Dall gives a very good figure of the central tooth (Am. Lyc. Nat. Hist., N. Y., Vol. IX, pl. ii, figs. 8, 10), and a number of primary and secondary teeth. His

figures, however, do not show the peculiar alternate arrangement of the denticles on the primary teeth, nor the number of the same.

Physa ancillaria Say.

The radula of this species is precisely like that of *heterostropha*.

Aplexa hypnorum Linné. Plate V, D.

Radula with a central tooth, as in *Physa* (?), excepting that the denticles are differently arranged, the central denticle being rather long, and having four shorter ones on either side; the base of attachment could not be made out; lateral teeth serrated similar to those of *Physa*, but the teeth equal in size and 9–10 in number, and rather long and pointed; the base of attachment is very long and rounded at the extremity. The writer counted 78 teeth (39–1–39) in a single row, and 230 rows in one membrane. The upper part of the base of attachment supports a peculiar lateral appendage in the form of a long and narrow projection, which may represent the secondary tooth in *Physa*. The dentition differs from *Physa*, principally in the form of the denticles on the primary teeth and in the absence (?) of the secondary teeth. The peculiar lateral appendage may be, as before remarked, a secondary tooth.

Pleurocera subulare Lea.

Jaw elongately ovate, the surface covered with numerous small, rounded, or polygonal scales.

Radula formula $\frac{1}{10} + \frac{1}{8} + 1 + 1 + 1 + \frac{1}{8} + \frac{1}{10}$ (3–1–3); central tooth with a low, wide base of attachment, the reflected portion 7-dentate, the central cusp very long, the side cusps very much shorter; intermediate tooth almost square, 5-dentate, the inner cusp small, the next cusp very large, and the three other side cusps small; lateral teeth more or less sole-shaped, longer than wide, the first 8 and the second 10 dentate; the outermost lateral flares a little at the upper part. In one membrane the writer counted 43 rows of teeth. The radula is very similar to that of *P. elevatum*.

PLEUROCERA ELEVATUM Say. Plate V, E.

Jaws as in *subulare.*

Radula formula $\frac{1}{11}+\frac{1}{8}+\frac{1}{7}+\frac{1}{3\text{-}1\text{-}3}+\frac{1}{7}+\frac{1}{8}+\frac{1}{11}$ (3–1–3); teeth generally as in *subulare*; the intermediate tooth has five outer cusps instead of three, as in *subulare*; the inner lateral has 8 or 9 cusps, all large, and the outer layer has 11 small cusps. All of the teeth seemed to have well-developed cutting points.

PLEUROCERA ELEVATUM LEWISII Lea.

Radula in all respects like that of the type form. *Lewisii* has no claims to specific rank, as the writer has seen many hundred specimens which show every gradation, from forms almost smooth to strongly striated ones.

ELIMIA LIVESCENS Menke. Plate V, F.

Jaw similar to those of *Pleurocera elevatum* and *subulare* (F, 4).

Radula formula $\frac{1}{10}+\frac{1}{8}+\frac{1}{5}+\frac{1}{9}+\frac{1}{5}+\frac{1}{8}+\frac{1}{10}$ (3–1–3); teeth in general similar to those of the Pleuroceridæ, excepting that the central tooth has 4 small cusps on each side of the central cusp instead of 3; the intermediate tooth has a medium sized inner cusp, a very large, rounded cusp next, and three small, rather sharp outer side cusps; the first lateral has 8 denticles and the second 10. The denticles are a little rounder in this species than in the family previously mentioned.

EXPLANATION OF PLATE IV.

A.—Pupa contracta Say. c. Central tooth. 1. First lateral. 7, 9, Marginals. 10. Jaw.

B.—Limnæa caperata Say. c. Central tooth. 1. First lateral. 8, 10, Transition teeth. 12, 14, 15, Marginal teeth.

C.—Limnæa desidiosa Say. 17, Transition tooth. 21, 22, 24, Marginal teeth. 35, Outer marginal.

D.—Limnæa palustris Müller. Abnormal first lateral.

E. Planorbis trivolvis Say. c. Central tooth. 1, First lateral. 8, Transition tooth. 14, Marginal tooth.

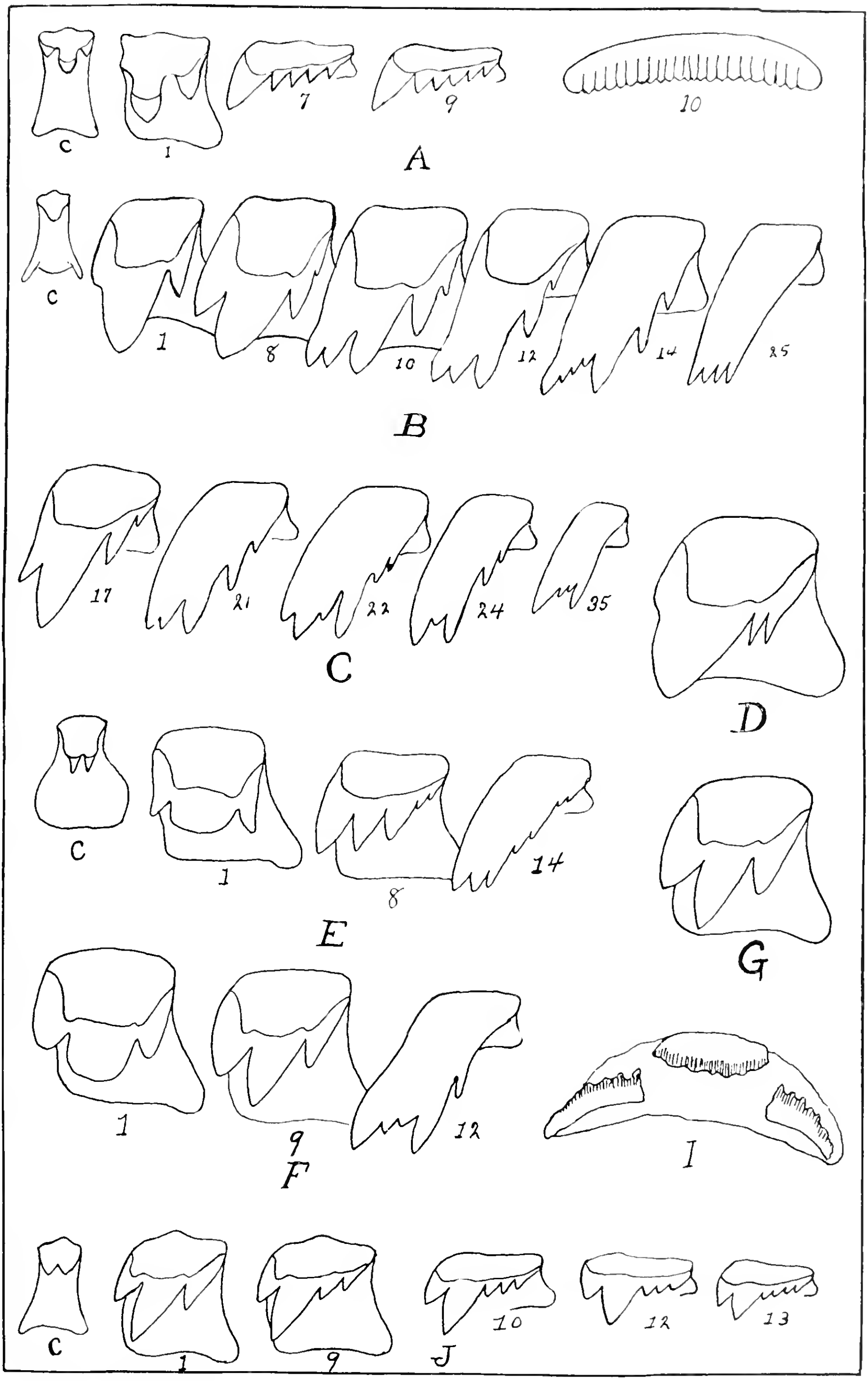
F.—Planorbis bicarinatus Say. 1, First lateral. 9, Transition tooth. 12. Marginal tooth.

G.—Planorbis campanulatus Say. First lateral.

I.—Limnæa columella Say. Jaw.

J.—Planorbis parvus Say. c. Central tooth. 1, First lateral. 9, Transition tooth. 10, 12, 13, Marginal teeth.

All but A, 10 and I × 600.



BAKER ON RADULÆ.

EXPLANATION OF PLATE V.

A. Segmentina armigera Say. c. Central tooth. 1, First lateral. 10, Transition tooth. 11, 15, Marginal teeth.

B.—Ancylus rivularis Say. c. Central tooth. 1, First lateral. 5, Transition tooth. 9, 13, Marginal teeth.

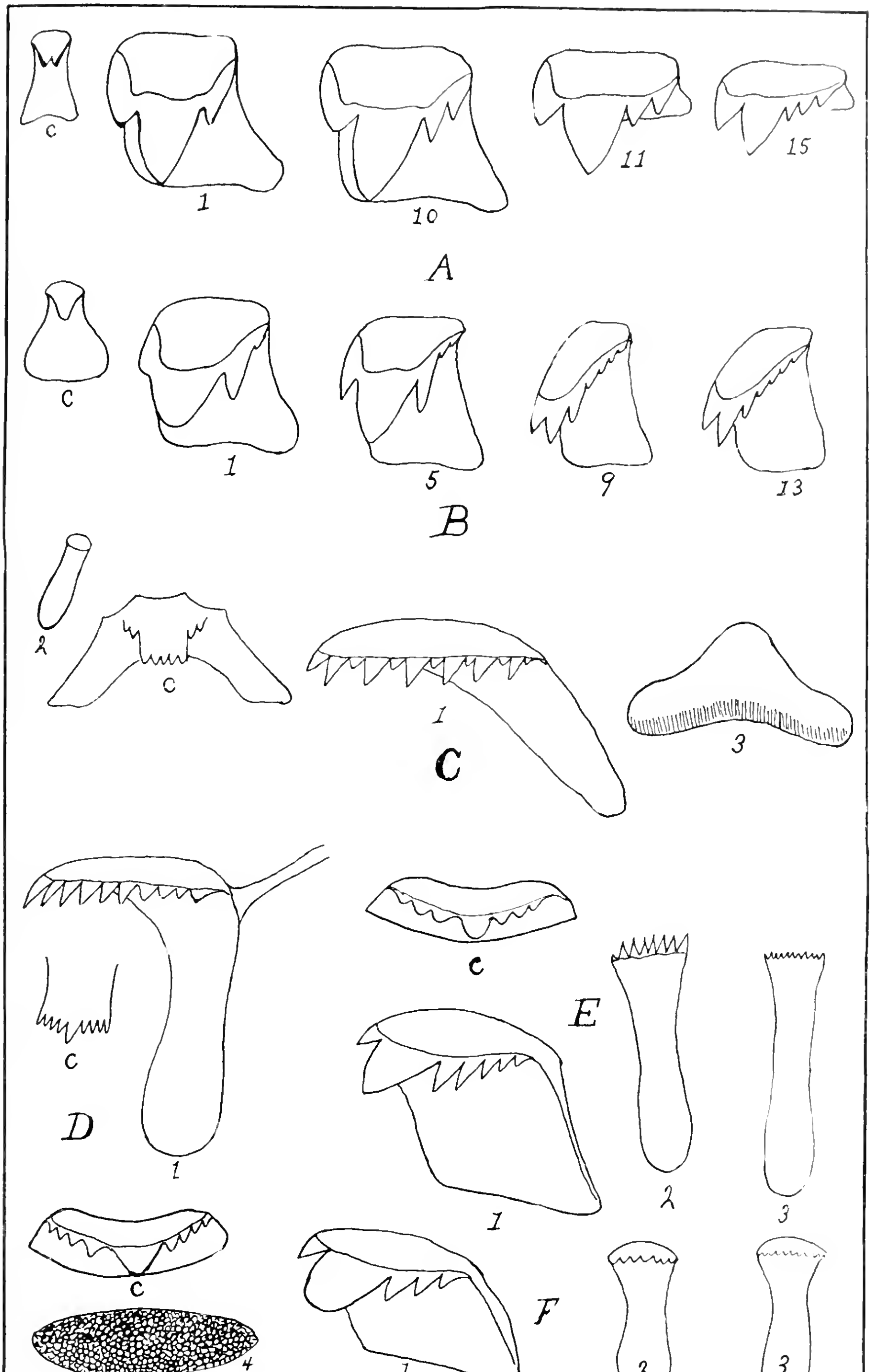
C.—Physa heterostropha Say. c. Central tooth. 1, Principal tooth. 2, Secondary tooth. 3, Jaw.

D.—Aplexa hypnorum Linné. c. Central tooth (cusp). 1, Lateral tooth.

E.—Pleurocera elevatum Say. c. Central tooth. 1, Intermediate tooth. 2, 3, Lateral teeth.

F.—Elimnia livescens Menke. c. Central tooth. 1, Intermediate tooth. 2, 3, Lateral teeth. 4, Jaw.

All but C, 3 and F, 4 × 600



BAKER ON RADULÆ.

ARTICLE X.—A BRIEF DESCRIPTION OF THE SECTION OF DEVONIAN ROCKS EXPOSED IN THE VICINITY OF ROCK ISLAND, ILLS., WITH A STATEMENT OF THE NATURE OF ITS FISH REMAINS.

By J. A. Udden, Rock Island, Ills.

A continuous section of the Devonian rocks exposed along the Mississippi River, where it crosses the east end of the Iowa area of this system, has not yet been published. I believe that the summary given below will prove to be nearly correct. The description begins with the lowest bed and continues upward.

1. A very pure limestone, bluish-gray or white, mostly thin-bedded, often brecciated, without fossils, except in the lowermost ledges, where a small *Spirifer* and a minute coral occur, and in the uppermost layers, where a single specimen of a cyathophylloid coral has been observed. Thickness about 70 feet. This limestone was referred to the Upper Helderberg by James Hall in 1858. The lower fossiliferous part appears to be the same as Prof. W. H. Norton's Otis beds. The greater part of these beds have by the latter author been called the Lower Davenport beds. Others have referred them to the Corniferous.

2. Three or four ledges of a strong, somewhat granular, thick-bedded limestone, with large cephalopods numerous corals and brachiopods and other fossils. Thickness about 7 feet. In part, the Hamilton limestone of Worthen; the Gyroceras beds of Calvin and Barris; the Upper Davenport beds of W. H. Norton. Referred by Barris to the Corniferous.

3. Three ledges of a fine-grained, bluish limestone, separated by seams of green shale, and containing brachiopods in profusion. Thickness, 6 feet. Referred by most older writers to the Hamilton age. The lower part of the Cedar Valley limestone of the Iowa geologists.

4. Shaly limestone, or calcareous shale, containing throughout a fauna, very much like that of the preceding member. Almost a crinoidal limestone in the upper part. Thickness somewhat variable, averaging perhaps 30 feet. The upper part of the Cedar Valley limestone of the Iowa Geologists.

5. A thin-bedded limestone, locally changing to a coral-breccia, or a shell-breccia, always containing in profusion such fossils as *Acervularia davidsoni*, *Cystiphyllum americanum*, *Atrypa reticularis*, *and Spirifer parryana*. Thickness about 10 feet.

6. Thin-bedded limestone and greenish shale, generally containing *Athyris vittata* in abundance. Thickness from 2 to 3 feet.

7. Somewhat thick-bedded and rather soft blue limestone, weathering yellow. Thickness about 5 feet.

8. Thin-bedded limestone, with a nodular *Stromatopora*, and with *Orthoceras* more or less common. Thickness about 2 feet.

9. Massive and finely granular, somewhat arenaceous, blue (when thoroughly weathered, brown) limestone in massive beds. Casts of corals and brachiopods. Thickness about 10 feet. Referred to the Chemung group by Hall, to the Kinderhook by Worthen, the Montpelier sandstone of Calvin.

10. A carbonaceous black seam of limestone, with a large *Stromatopora*. Thickness seldom more than one foot. Sometimes absent.

11. A hard, coral-bearing limestone, usually much changed by weathering, originally bluish in color, but now mostly brown, and with casts of fossils. Thickness unknown, not over 10 feet.

12. A greenish or yellow shale with brachiopods. Thickness unknown, probably not over 5 feet.

13. A variable, occasionally brecciated, and often much weathered limestone, with corals and gasteropods. Thickness unknown.

The lithological character of the several beds changes somewhat horizontally, but the change is never very great. The appearance of the rocks in exposures is often considerably

modified by weathering, and this sometimes renders the recognition of each bed difficult. There is a variable but general dip to the south and west, and a noticeable diminution in the thickness of the beds to the south.

Remains of fish are occasionally found in at least four of the beds described above. In No. 2 there is quite a variety of teeth of cestraciont sharks. Many of these teeth resemble the form described as *Ptyctodus*. From No. 3 a nearly entire armor of a placoid fish was found near Rock Island some years ago. Two small pieces of the plates, or jaws, of these fishes have been found in No. 4, and a fin-spine* has also been taken from this bed. No. 9 contains teeth resembling those in No. 4. The fish remains of Nos. 2–9 may hence be said to resemble those of the Hamilton period in the Eastern States.

ARTICLE XI.—DESCRIPTION OF A DEVONIAN ICHTHYODORULITE, HETERACANTHUS UDDENI, N. SP., FROM BUFFALO, IOWA.

By Josua Lindahl, Ph. D.

The fish-spine referred to by Professor Udden in his paper, "A Brief Description of the Section of the Devonian Rocks in the Vicinity of Rock Island, Ill. . . . etc." (Article X of this volume, p. 93), is closely related to the similar spines found in the cement beds of Hamilton Age at Milwaukee, Wisconsin, and described by Professor Newberry under the name of *Heteracanthus politus*. As the specimen now under consideration appears to represent a hitherto undescribed species, and necessitates a modification of Professor Newberry's characterization of the genus *Heteracanthus*, I wish here to give a description of the specimen which Professor Udden has had the kindness to present to the museum of the Cincinnati Society of Natural History.

* Described hereafter by J. Lindahl under the name *Heteracanthus uddeni*.—[Ed.]

Genus: HETERACANTHUS. Newberry.

Synonymy:

1889. Heteracanthus, J. S. Newberry: "The Paleozoic Fishes of North America;" Monograph, U. S. Geological Survey, Vol. XVI., p. 65; Plate XXI., Figs. 4, 4a, and 5.

1892. Gamphacanthus, S. A. Miller: "North American Geology and Paleontology—First Appendix," p. 715.

Emended description of the genus: Pectoral (?) spines, robust, covered with highly polished enamel, divided by narrow furrows into flattened longitudinal ridges, some of which have their edges more or less regularly denticulated; posterior side straight and, along the greater part of its length, broadly gouged into a rough groove for the attachment of muscles; anterior side transversely arched, the anterior profile *f*-shaped, being slightly convex near the summit, and strongly concave toward the base, which is considerably produced forward; the lateral sides of the shaft sub-equally convex, flattening toward the base; the basal portion almost flat on one (the outer) face, decidedly concave on the other (the inner) face; the ridges are most numerous on the basal portion of the spine, but terminate in succession above, so that few reach the conical-pointed summit.

As pointed out by Newberry, the want of symmetry in these spines shows that they have belonged to some paired organs; no doubt pectoral fins.

In our specimen, the concave right face of the basal portion (see Fig. 5) indicates that it has had its place on the left side of the body.

The base is obliquely rounded below on the inner face; on the outer face it is bounded by two straight lines meeting below at an angle of about 65°; but as this side has been trimmed rather too closely, I am uncertain whether or not the said straight lines represent the original outlines of the specimen, though it seems probable that nothing but the very edge of the specimen has been removed. The number of ridges on the base is about eighteen to the half-inch, and each ridge is about one and one-half times as wide as an adjacent furrow; while, two inches from the summit of the shaft, there are only about six ridges to the half-inch, and the average width of a ridge is here about five times as great as that of an adjacent furrow.

The bottoms of all the furrows in our specimen are even—not "sinuous," or "denticulate," as Newberry describes the "sutures" of *H. politus*—while the outlines of their borders are determined by the form of the lateral edges of the adjacent ridges. Thus both, or one, or neither of the borders may be sinuous. In our specimen (see Fig. 6) only two ridges of the anterior side have regularly denticulated edges (with about twenty teeth to the half-inch); consequently the furrow which separates them has both borders sinuous, while the furrow next in order on either side has its anterior border sinuous, the posterior even; all the following furrows of the lateral faces have both borders even. There occur, however, particularly on the inner (right) side of the specimen, occasional minor irregularities in the edges of some ridges in various portions of the shaft, somewhat reminding of the undulating lines in Newberry's figure 4a, though very different from the denticulations of the two anterior ridges.

The proportion of length to greatest width is about 3 to 1 (length, 5.9 inches; width, 2 inches). In this our specimen differs greatly from Newberry's description of *H. politus*, where the proportion is about 6 to 1 (length, 8 to 10 inches; width, 1½ inches).

These different proportions, and the above-described denticulations of the anterior ridges, characterize our specimen as the type of a new species, for which I propose the name HETERACANTHUS UDDENI, in honor of the discoverer, my esteemed friend, Prof. J. A. Udden.

If Mr. Miller's reason for changing the name of the genus—viz, that the name *Heteracanthus* was pre-occupied for a genus of worms—be regarded valid, the name would stand as *Gamphacanthus uddeni*.

Formation and locality: Devonian, Hamilton Group; bed No. 4 (Udden l. c.); crinoidal limestone; near Buffalo, Iowa. *Found* by Prof. J. A. Udden, of Augustana College, Rock Island, Ills.

The type specimen is the property of the Cincinnati Society of Natural History, and is entered in the Museum Catalogue as No. 14,558.

EXPLANATION OF PLATE VI.

Fig. 1.—Right side of left pectoral spine of *Heteracanthus uddeni;* natural size.

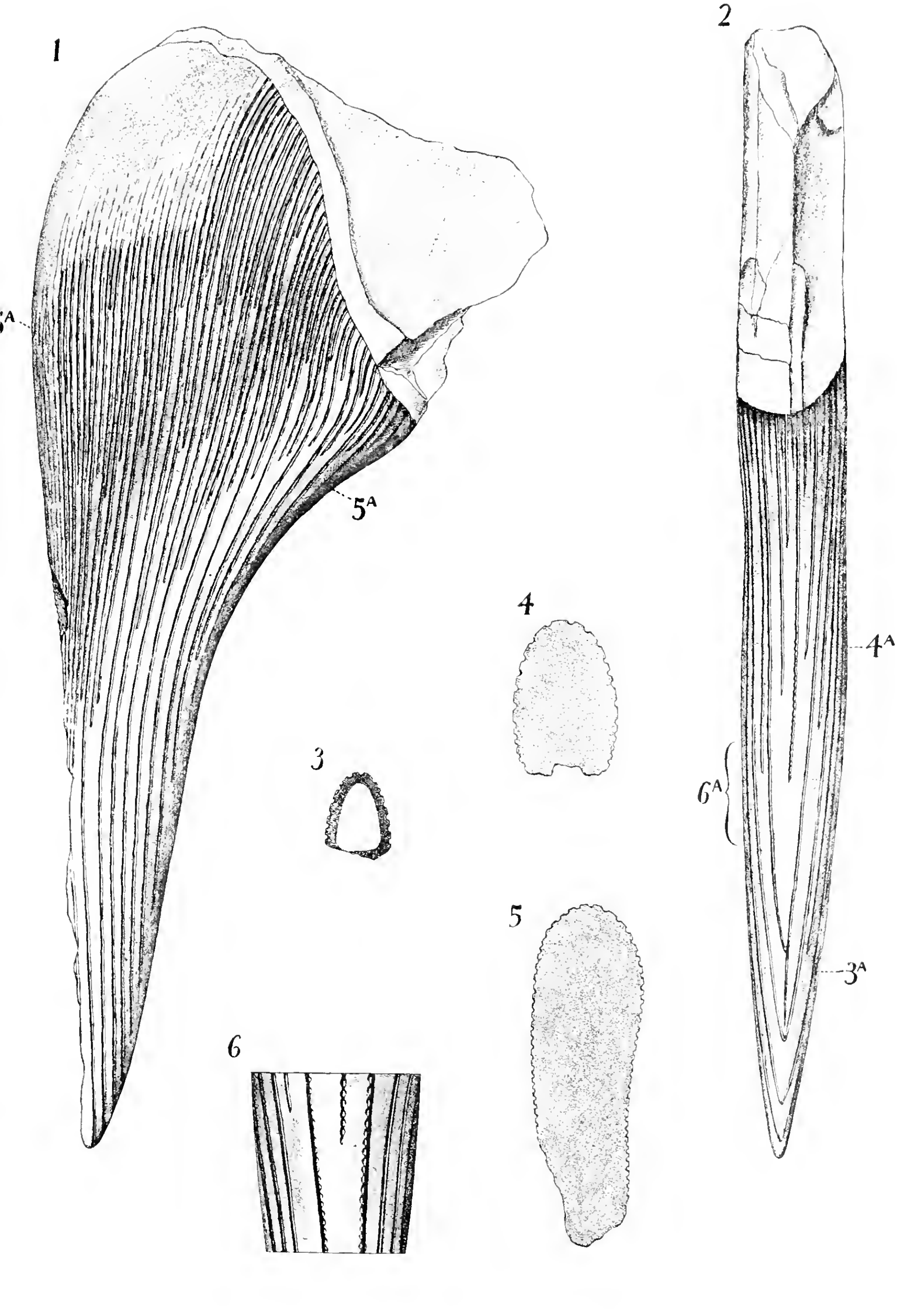
Fig. 2.—Anterior side of same; natural size.

Fig. 3.—Transverse section of shaft at 3A, fig. 2; natural size.

Fig. 4.—Outline of transverse section of same at 4A, fig. 2; natural size.

Fig. 5.—Outline of section taken obliquely across the basal portion of the spine at 5A–5A, fig. 1; natural size.

Fig. 6.—Portion of anterior side at 6A, fig. 2; enlarged.



A. Albers. DEL.-SC.

TERACANTHUS UDDENI Lindahl.

ARTICLE XII.—MANUAL OF THE PALEONTOLOGY OF THE CINCINNATI GROUP.

BY JOSEPH F. JAMES, M. D., M. SC., F. G. S. A.

PART VIII.

(Continued from Vol. XVIII, p. 140.)

Division B. PELMATOZOA.*

Class 3. CRINOIDEA.

This is by far the largest class of Echinodermata in our region and includes many beautiful forms. In some localities they are remarkably abundant, and whole layers of rock are frequently made up of their stems. The animals have lived from the earliest Silurian times to the present, and the anatomy of the extinct forms may be fairly inferred from the living ones. The features of the class are as follows:

Body fixed during a portion or the whole of the life of the animal to the sea bottom by means of a flexible jointed column or peduncle, springing from the center of the dorsal or aboral surface, cup-shaped or discoidal, with the dorsal surface protected by a system of calcareous plates; mouth in the upper surface, generally in the center; jointed, flexible appendages or arms, springing from the margin of the cup-shaped body, primitively five in number, and having lateral processes or pinnules; the upper (or ventral) surfaces of the arms furnished with grooves in which are situated the reproductive organs; sometimes, however, these are in the pinnules, or, in living forms, beneath the skin.†

In the arrangement of the genera and species of our section the classification adopted by Wachsmuth and Springer (Revision of Palæocrinoidea) has been followed. Considerable

* This includes forms possessing stalks.

† Nicholson, Manual of Paleontology, 1889, Vol. I, pp 408, 409.

diversity in the descriptions of the various species will be observed. This is due to the various plans followed by the different writers. There is a lamentable lack of uniformity in describing many fossils that often renders any comparison difficult. No division of families has been attempted in the present enumeration. The following "Key," although imperfect, may be useful in locating the genus of a given specimen.

Key to Genera.

Under basals, 5, generally well developed; basals, 5; arms, 10–24 or more; column sub-pentagonal.

1.— RETEOCRINUS.

Under basals small or absent; basals, 5; arms, 10–30; column round.

2.— CANISTOCRINUS.

Under basals small or absent; basals, 4; arms, 10; column square.

3.— XENOCRINUS.

Under basals, 5; basals, 5; arms, 20; column round.

4.— PTYCHOCRINUS.

Under basals absent; basals, 5; arms, 20; column round or pentagonal.

5.— GLYPTOCRINUS.

Basals, 4; arms, 20; column square.

6.— MARIACRINUS.

Basals, 5, unequal; radials, 5, irregular; arms, 10; column round or pentagonal.

7.— HETEROCRINUS.

Basals, 5, unequal; radials, 5, irregular; arms, 10; column round, tripartite.

8.— ECTENOCRINUS.

Basals, 5, irregular; radials, 5, irregular; arms, 10; column pentagonal, pentapartite.

9.— OHIOCRINUS.

Basals, 5, regular; radials, 5, nearly regular; brachials many; arms, 10 (?); column pentagonal.

10.— IOCRINUS.

Basals, 5, very irregular; radials, 5, very unequal; brachials irregular in number; column round, tuberculated.

11.—ANOMALOCRINUS.

Under basals, 5; basals, 5; column round, nearly smooth.

12.—MEROCRINUS.

Basals, 5; column round or pentagonal; pinnules wanting.

13.—DENDROCRINUS.

GENUS 1.—RETEOCRINUS Billings, 1859.

Calyx obconical, somewhat bilateral; interradial and interaxillary spaces depressed; radial plates elevated into strong, rounded ridges, resembling arms; they bifurcate and follow the secondary radials, thence passing into free-arm joints; *underbasals* 5, well developed; *basals* 5, large, protuberant, hexagonal, the upper side slightly truncate, and supporting the first series of interradial plates; *radials* 3×5, those of the different rays separated by interradials: the first and third pentagonal, second quadrangular; as long as, but narrower than the two former; radials highly elevated, forming a broad, rounded ridge, branching from the third radials upward, following the secondary radials, and downward from the first primary radials to the basals; *secondary radials*, 4 to 5 in the adult, less in young specimens, quadrangular, decreasing in height upward, shaped like arm joints, and giving off pinnules; *arms* 10 to 24 long, slender, rounded, bifurcating, composed of a single series of rectangular or slightly wedge-shaped pieces, which give off on alternate sides rather stout, closely-arranged pinnules; *interradial* series resting directly on the basals, consisting of a very large number of minute pieces, irregular in shape and without definite arrangement; the posterior area wider, with a conspicuous row of decidedly larger and more prominent special anal pieces along the median part; *interaxillary* plates almost as numerous as the interradials, and similar in character; *vault* composed of numerous, very small and convex pieces, with an elevation running to each arm base; *anal* aperture directly through the vault, small, sub-central; *column* sub-pentagonal; central

canal rather large. (Canadian Organic Remains, Decade 4, 1859, p. 63; Wachsmuth & Springer, Review of Palæocrinoidea, Pt. II, 1881, p. 192.)

Remarks.—Originally described by Billings, this genus was redescribed by Wachsmuth and Springer in 1881, and this amended description is given above. Various changes have been made from time to time in the species referred to the genus, but at present those given below are the ones generally recognized as belonging to it from our region.

1.— R. O'NEALLI Hall, 1866.

Calyx turbinate, gradually spreading from the base to the free arms; deeply pentalobate below the third radial plates, from the depression of the interradial space; ten lobed above from the depression of the intersupraradial areas; *under-basals* well developed but small, and presenting a low, triangular face on the exterior with very slightly truncated lateral angles; *basals* larger, heptagonal, height and width about equal; upper extremities truncated by the interradial and anal plates; *primary radials* subequal in size, the first and third having a general pentagonal form, and the second quadrangular; *supraradial* series, consisting of 14 to 16 plates — sometimes less — large in the lower part, becoming gradually smaller above, the upper ones about five times as wide as high; the lower plates attached to the calyx and dome by the intersupraradial and summit plates, while the upper, smaller plates are free and bear tentacles; *interradial* and *anal* plates very numerous; those of the middle range passing from the basal plate upward are largest; the plates between these and the row are small, some of them minute; anal area with 50 to 60 plates; 40 to 50 in the interradial, and 20 or more in the intersupraradial; *arms* 20, composed of a single series of very short plates, higher on one side than on the other, but bearing tentacles on the longer side only; *tentacles* long and slender; *surface* of radial plates marked by an elevated, rounded ridge, which bifurcates on the first and third radials, the branches passing to the basals and thence to the under basals; no other surface marking seems to have

existed except the presence of a finely granulose texture. (Advance sheet 20th Rept., N. Y. State Mus. Nat. Hist.; 24th Rept.; Ibid, 1892, p. 206; Meek, Pal. of Ohio, Vol. I, p. 34, as *Glyptocrinus*.)

Locality.—Lebanon and Cincinnati, Ohio.

2.— R. COGNATUS S. A. Miller, 1881.

Body turbinate, strongly pentagonal, height about equal to width; *under-basals* 5, with a height at the superior angle nearly equal to ½ the width of a plate; *basals* 5, comparatively large, heptagonal, about as wide as high, depressed at the line of junction and elevated in the central part; each plate rests on 2 of the under basals, and supports on the upper sloping sides the radials and on the superior face an interradial; first *primary radial* heptagonal, about as wide as high and a little larger than either of the others; second and third hexagonal, higher than wide, the 3 forming a convex elevated ridge; the third supports on its upper sloping sides the secondary radials, and on its superior face an axillary or intersecondary radial plate; about 8 of the *secondary radials* form part of the body, gradually diminishing in length and about the eighth giving rise to the free arms; regular interradial areas deeply excavated and occupied by about 40 plates, the axillary areas having about 20 plates. (Jour. Cin. Soc. Nat. Hist., Vol. IV, p. 75, as *Glyptocrinus*; Ibid, Vol. VI, p. 229, as *Gaurocrinus*.)

Locality.—Middletown, Ohio.

Remarks.—This species is considered by Mr. Miller to be a close ally of *R. o'nealli*.

3.— R. GRACILIS Wetherby, 1881.

Body broadly ovate; *under-basals* 5, very small; *basals* 5, hexagonal, somewhat higher than wide, truncated above; outer angles of upper ends cut off, forming an articulating surface for first radials; widest at the lateral angles and separating from each other below, so as to leave an opening through which the under basals and top of column are seen;

first radials 5, pentagonal, higher than wide, truncated above; *second radials* 5, quadrangular, higher than wide, equal in size, truncated above and below, lateral margins depressed; *third radials* 5, pentagonal, higher than wide, wider above, with two articulating surfaces upon which the rays divide; lateral edges depressed into the borders of the interradial spaces; upper margin slightly excavated; *brachials* in two series, the first 10, quadrangular, higher than wide, equal in size and alike in form; second series 10, pentagonal, higher than wide, wider above with 2 articulating facets, from each of which an arm arises; *arms* 20, long, slender, composed of equal, quadrangular pieces, about as wide as high; *pinnules* long and delicate, originating on alternate arm plates; *anal* and *interradial* spaces filled by a great number of small, delicate, generally hexagonal plates. (Jour. Cin. Soc. Nat. Hist., Vol. IV, 1881, p. 83.)

Locality.— Cincinnati, O.

4.— R. MAGNIFICUS S. A. Miller, 1883.

Body robust with prominent radial ridges; *under basals* 5, low, small, triangular on the outer face; *basals* 5 longer than wide, ridge prominent; *primary radials* 3×5, first and third series of about equal size; *secondary radials* 4 or 5×10, a ridge arising from the second and passing upward toward the vault; no tertiary radials; *arms* 24, bifurcating soon after becoming free, when 4 again bifurcate; composed of cuneiform plates, large and long with strong pinnules; first *interradial* rests on the superior side of a basal, and is followed by about 20 interradials not disposed in transverse ranges; *column* pentagonal. (Jour. Cin. Soc. Nat. Hist., Vol. VI, 1883, p. 230, as *Gaurocrinus.*)

Locality.—Warren Co., O.

GENUS 2.—CANISTOCRINUS Wachs. & Spring., 1885.

Closely resembles *Reteocrinus* in general aspect; radial ridges strong, tube-like; interradial spaces deeply depressed; symmetry bilateral; *underbasals*, perhaps, indistinctly devel-

oped or absent; *basals* 5, truncated above for the reception of the lower series of interradials; *primary* radials 3×5, of nearly equal size, the first and third nearly similar in form, the ridges of the former branching downward toward the basals, those of the latter upward toward the secondary radials, which they follow until these turn into free arm plates; *arms* branching or simple, composed of single joints, which give off rather strong pinnules; *interradial spaces* composed of numerous small pieces, without definite arrangement; the plates rest upon the basals, separating the 5 rays from the base up; with the increase of interradials and interaxillaries by age, more radials seem to be gradually incorporated into the calyx, involving the proximal pinnules, the plates of which are easily recognized from surrounding interradial and interaxillary pieces by being more prominent. *Azygous* interradius wider than the four others, with an elevated ridge composed of rather large anal pieces, which are longitudinally arranged and have somewhat the appearance of radials; the interaxillary areas depressed even deeper than the interradial ones, consisting of similar plates. (Review of Palæocrinoidea, Part III, 1885, p. 94.)

Remarks.—The two species placed here have been considered as belonging to both *Reteocrinus* and *Glyptocrinus*. Wachsmuth and Springer believe they present features that justify the erection of this new genus. It is most nearly allied to *Reteocrinus*.

1—C. PATTERSONI S. A. Miller, 1882.

Calyx small, height and width sub-equal; interradial areas depressed; surface finely sculptured; *basals* small, projecting up between the under sloping sides of the first primary radials; *first radials* largest in the body, hexagonal, about as long as wide; the strong radial ridge in its extension below divides at the center of this plate; *second* and *third radials* much smaller than the first, about as high as wide, hexagonal or heptagonal, and of about equal size; *secondary radials* arise from upper sloping sides of the second primary radials (?) and become free arms at the third plate; *arms* 10, consisting, after becoming free, of strong cuneiform plates, each bearing

a strong pinnule; *column* round, of medium size, and composed, near the head, of alternately thick and thin plates. (Jour. Cin. Soc. Nat. Hist., Vol. V, 1882, p. 80, as *Glyptocrinus.*)

Locality.—Opposite Cincinnati, Ohio, in Kentucky.

Remarks.—The description of this species is obscure in regard to the origin of the secondary radials, and as the author says his figures are incorrect, it is not possible to check one by the other.

2.—C RICHARDSONI Wetherby, 1880.

Under-basals not developed, or so slightly as not to be characterized; *basals* 5, pentagonal wider than high, alternating with the first radicals; *radials* 3 × 5, in the first series pentagonal, somewhat higher than wide, each elevated in the center; second and third series hexagonal, higher than wide, and resting squarely upon each other, as the second rest upon the first, and like the first radials with a central elevation; rays dividing on the third radials; *interradials* hexagonal, and so arranged on all except the azygous side that there is at first one piece, then two above this for 2 or 3 ranges, above which the arrangement is indefinite; *azygous* side has first 1 plate, then 2 in the first range, and 3 in a few succeeding ranges, and then indefinite; *interaxillaries* numerous, hexagonal or pentagonal, slightly elevated in the center; before the arms become free, a number of jointed processes, like large pinnules, are sent off; *arms* 30 (?), composed of nearly equal slightly cuneiform plates, long, tapering gradually, and with elongated pinnules, which are 10 or 12 jointed; *column* round. (Jour. Cin. Soc. Nat. Hist., Vol. II, 1880, p. 245, as *Glyptocrinus.*)

Locality.—Wilmington, Ohio.

Genus 3.—XENOCRINUS S. A. Miller, 1881.

Base monocyclic; *basals* 4, combined, forming a shallow decagonal cup, which, upon 5 of its sides supports the 5 *radials*, and alternately, upon each of the 5 other sides, a series of small interradial pieces; all the basals different in

form; axial canal pentangular; in other respects agrees with *Reteocrinus* and *Canistocrinus; arms* 10; *column* square. (Jour. Cin. Soc. Nat. Hist., Vol. IV, pp. 71, 1876. Wachsmuth & Springer, Revision of Paleocrinoidea, part 3, 1885, p. 95.)

Remarks.— The above is mainly the description of Wachsmuth & Springer. Two species have been referred to the genus which are given below.

1.— X. PENICILLUS S. A. Miller, 1881.

Basals 4, uniting at the angles of the column, about twice as wide as high, 2 hexagonal, 2 pentagonal, with a granulous surface; *primary radials* 3 in each series, about twice as long as wide, each series forming a convex, elevated ridge, contracted at point of union of plates; 4 of the series supported in the angles formed at the junction of the basals, the 5th or posterior series supported on the middle of the basal opposite the azygous side; these plates all about the same length; *third primary radials* a little wider above than the others, and supporting on the 2 superior sides the secondary radials; *secondary radials*, or brachials continued into the free arms, the first plate about as long as a primary radial and gradually decreasing until the sixth plate is only about one-half as long as wide; above this, plates shorter, but of about the same width until arms are free from vault when they become cuneiform, with the width equal to the length of about 3 plates; *interradial* and *inter-secondary* radial spaces long, narrow and depressed, covered with small plates, each with a short spine or tubercle in the center; about 75 plates in each interradial area, and 25 or more in each inter-secondary radial area before reaching the top of the cup, the plates continuing over the margin and top (?) of the vault, and also more or less of the long probosis; *azygous* area large, covered by a series of 7 plates, each about twice as long as wide; *arms* 10, composed of cuneiform plates; pinnules comparatively coarse, forming a dense fringe on each side, and composed of more than 12 plates; *column* quadrangular at the head, round (?) below, perforated by a small, round orifice. (Jour. Cin. Soc. Nat. Hist., Vol. IV, 1881, p. 72.)

Locality.— Warren County, Ohio.

2 — X. BAERI Meek, 1872.

Body of medium size, globose-obconoidal; *under-basals* apparently not developed, or very small; *basals* 4, short and pentagonal; first *primary radials* of comparatively moderate size, presenting a general heptagonal outline; second a little narrower than the first, but of nearly the same length, with a general quadrangular form; third slightly larger than the second and pentagonal; *secondary radials* consisting of about 4 pieces in succession on each upper sloping side of each primary radial, the first 2 or 3 of each series only about one-third smaller than the second ones, while above this the succeeding pieces soon become much shorter, free brachials; *interradial* pieces numerous, small, of very unequal size, without any regular arrangment; *anal* series unknown, probably consisting of a mesial series irregularly arranged between these and the radials on each side; *arms* 10, rather long, simple, widest a little above their bases, and then gradually tapering to their ends, and composed of very short pieces so strongly cuneiform as to appear almost to taper to nothing alternately on opposite sides, while each supports a pinnule at its thicker end; *pinnules* very long, moderately stout, nearly in contact, and composed of pieces that are 3 or 4 times as long as wide; *surface* of body plates without costæ or striæ, those of the primary and secondary radial series more prominent than the much smaller pieces filling the interradial and axillary spaces, and thus forming somewhat flattened ridges, more or less interrupted at the sutures and abruptly beveled at the sides; *interradial* and *axillary areas* roughened by a minute projection on each of the little pieces filling the same; *column* of moderate thickness, apparently quadrangular or pentagonal near the base, and composed of alternate thick and thin pieces, the former projecting a little beyond the latter. (Am. Jour. Sci., ser. 3, vol. 3, p. 260; Pal. of Ohio, vol. 1, p. 37, as *Glyptocrinus*.)

Locality.— Richmond, Ind., and Warren County, Ohio.

Remarks.— There is some discrepancy in the various descriptions of this species. Meek does not mention the number of basals; Miller says there are 5 (Jour. Cin. Soc. Nat. Hist., Vol. VI, p. 226); while Wachsmuth and Springer say positively 4. The column is *probably* quadrangular.

GENUS 4.—PTYCHOCRINUS Wachs. & Spring., 1885.

In general form resembles *Glyptocrinus;* radials with a fold-like strong, tubular ridge along their median line; interradial spaces depressed; *under-basals* 5; *basals* 5, large, all hexagonal; *primary radials* 3×5; first ones heptagonal, but upper-sloping sides, facing the azygous side, longer, forming a deep notch for a very large anal plate; *secondary radials* 3 or more, having the appearance of arm-plates, and gradually passing into free joints; strong arm-like pinnules given off from alternate sides; *interradials* consisting of 1 plate in the first row, 2 in the second, and 3 in the third; azygous side wider; first plate extending far down between the first radials, sometimes touching the basals, and 3 plates instead of 2 plates in the second series; *column* small, cylindrical. (Review of Palæocrinoidea, Part III. [in Proc. Acad. Nat. Sci. Phil. for 1885], p. 100.)

Remarks.—This genus was formed by Messrs. Wachsmuth and Springer for the reception of 3 species, two of which had been referred by Miller to his *Gaurocrinus.* Two of these occur in our own region, and are given below:

1.—P. ANGULARIS Miller & Dyer, 1878.

Body angular, due to the depression of interradial spaces, and the downward extension of the basals below junction of the column; radial pieces marked by a strong ridge, ornamenting the surface; *under-basals* 5, small, pentagonal, wider than high; *basals* 5, hexagonal, two lower faces resting between under-basals, and two upper-sloping sides supporting the first radials; each basal with an angular or wedge-shaped tubercle; *first radials* larger than the basals, heptagonal, wider than long; *second and third radials* smaller and hexagonal; first *secondary radial* hexagonal, longer than wide; second, heptagonal, supporting on each of the upper sides a series of brachial pieces; *interradial* spaces have an hexagonal plate between the upper sloping sides of the first radials, followed by 2 plates on its upper sides, and these by 3 plates in a row between the lower part of the first secondary radials,

and above about 6 small plates; only 2 plates observed in intersecondary radial spaces; *azygous* space filled by a range of elevated plates resting on one of the basal plates; *arms* moderately long, composed of very short plates, with long, strong pinnules; *column* small, round. (Jour. Cin. Soc. Nat. Hist., Vol. I, p. 28, as *Glyptocrinus*: Miller, Ibid., Vol. VI, 1883, p. 229, as *Gaurocrinus*.)

Locality.—Cincinnati, O.

2.—P. PARVUS Hall, 1872.

Body small, narrow, turbinate to the bases of the free arms; *basals* about equal in height and width; *radials* sub-equal, the first ones a little the largest; *rays* divided on the third radial, and again on the second supraradial, above which the pieces are smaller and soon become free, forming the arms; *interradial* areas, containing about 6 or more plates, varying from pentagonal to heptagonal; inter-supraradials 1, 2, or more; *arms* long and slender, with tentacles on the sides of alternating plates, long and comparatively strong; *surface* of plates smooth, and the center of those composing the rays strongly elevated, forming a strong ridge along the ray to the arms. (24th Rept. N. Y. State Mus. Nat. Hist., p. 207, as *Glyptocrinus*; 2d edition of 20th Repts. of Ibid., 1891.)

Locality.—Cincinnati, O.

Remarks.—Hall says of this that it "may possibly prove to be the young" of *Glyptocrinus decadactylus*.

GENUS 5.—GLYPTOCRINUS Hall, 1847.

Calyx obconical to subglobose; *surface* ornamented with radiating striæ in the form of elevated ridges, dividing into numerous triangular impressed areas; *under-basals* absent; *basals* 5, uniform in size, small, scarcely extending to the sides of the body, slightly concave for the attachment of the column; *primary radials* 3 × 5, the lower series somewhat larger, nearly similar in form, the second hexagonal; the third pentagonal in outline, and supporting the secondary radials; *secondary radials* varying in number from 2 to 8 or

more; *tertiary radials*, when present, also variable, separate or united according to the age of the specimen; *arms* 20, rising almost vertically from the last radial, long, slender, simple from the second division, rounded on the outer side, and composed of a single series of short, somewhat wedge-shaped pieces, each one of them supporting, at its larger end, a pinnule; *pinnules* very slender, alternately and very closely arranged, proximal ones fixed in the body walls, the first generally given off from the second secondary radials; *inter-radial* areas occupied by a large number of pieces, arranged in 4 or more series, with 1 plate in the first, 2 in the second, and generally 3 in each succeeding series; the *anal* area differs from the others in being a trifle wider, and in having 3 instead of 2 plates in the second and all succeeding series; *interaxillary* plates from 1 to 10; vault scarcely elevated above the horizon of the arm bases; *interradial* regions somewhat depressed, and composed of numerous very small convex plates; anal aperture directly through the vault, eccentric; *column* round, medium size; central canal small, distinctly pentagonal. (Pal. New York, Vol. I, p. 280; Wachsmuth & Springer, Review of Palæocrinoidea, Part 2; (Proc. Phila. Acad. Nat. Sci. for 1881), p. 187.)

(*Pycnocrinus* S. A. Miller, 1883, Jour. Cin. Soc. Nat. Hist., Vol. VI, p. 231.)

Remarks.—Originally proposed by Hall in 1847. A number of species have been placed in this genus. The revised and restricted definition given above is that of Wachsmuth & Springer. *Pycnocrinus* is placed by them as a synonym formed, they believe, on a young *Glyptocrinus*.

1.—G. DECADACTYLUS Hall, 1847.

Body obconoidal, with interradial and axillary areas a little flattened, so as to present a pentagonal outline; somewhat wider than high; *under-basals* undeveloped; *basals* small pentagonal, wider at the top than high; *first radials* larger than basals, as wide as high, heptagonal; second radials a little smaller than the first, hexagonal or heptagonal; third radials same size as second heptagonal and each supporting 2 *secondary radials*, each nearly as large as the third primary

radial; on the second of these secondaries another bifurcation, giving origin to 2 series of brachials, the first 2 or 3 of which appear like tertiary radials, free arms continued from these pieces; *interradial* series have 1 piece in first range, between the superior sloping sides of the first primary radials, 2 in second range, 3 in third and fourth; above the latter 10 or 12 small pieces; *anal* area with about same number of pieces as interradial, with three in each range above the first piece; *axilliary* areas with about 3 small pieces, and each *interbrachial* area with 2 or more small pieces; *arms* 20, 4 to each ray, long, slender, simple, rounded on outer side, each composed of a single series of wedge-shaped pieces, each of which supports a pinnule at the upper end; *pinnules* alternately and closely arranged along the inner, lateral margins, very slender and composed of joints 3 or 4 times as long as wide; *surface* ornamented with radiating costæ, those passing up the middle of the radials larger and more prominent than the others; others radiate from center of body plates to the sides, where they connect with those on contiguous plates; *column* of moderate size, round near base composed of thick and thin segments. (Pal. of N. Y., Vol. I, p. 281; Meek, Pal. of Ohio, Vol. I, 1873, p. 30.)

Locality.—Cincinnati, Ohio; Madison, Ind.; Maysville, Ky., etc.

Remarks.—This is a common and very beautiful species in our region, being well characterized by its sculpturing. It is closely allied to the following (*G. dyeri*), but can be readily distinguished by having only 2 secondary radials instead of 9 or 10, as in *dyeri*. It is also a much more widely distributed species, *G. dyeri* being restricted in its range.

2—G. *dyeri* Meek, 1872.

Body globular, sub-turbinate, wider than high, with sides rounding under to the base; *under-basals* obsolete, or if present not exposed externally; *basals* very small and projecting as a thin rim below, much wider than high, and trigonal in general outline, with the lateral angles minutely truncated; *first radials* of moderate size, heptagonal, wider than long; second and third a little smaller, the second being hexagonal

and the third pentagonal, and supporting on its superior sloping sides the first divisions of the rows; *secondary radials* 8 to 11 in number, rapidly diminishing in length upward to the second bifurcation or commencement of the arms just below where a few of the smaller pieces seem to be free and bear pinnules on their inner sides; further down the second and fourth secondary radials of each ray give off, alternately on each side, small divisions that do not become free, giving rise to pinnules at the summit of the body; *anal* area a little wider than the interradial areas; first anal plate of about the same size as the first radials, hexagonal, and supporting in the next range 3 pieces arranged with the middle one higher than the others; while above these 3 smaller pieces can be seen arranged in the same way in the third range and 3 to 4 or 5 in the fourth; the middle plates of this series form a direct vertical row that has a rather prominent mesial, rounded ridge extending all the way up from the middle of the lowest pieces of about the same size as those passing up the primary and secondary radial series, while the other plates on each side and other parts of the lowest pieces are ornamented with radiating costæ of smaller size, like those of the interradial pieces; *interradial* areas, not excavated below, but becoming moderately concave above; first *interradial* pieces about the size of the second primary radials, hexagonal, and supporting 2 other smaller pieces in the next range, that bear between their superior sloping sides a fourth smaller piece; while above this there are two pieces in the next range that connect with the pieces of the little lateral division of the secondary radials, and perhaps some other small intercalated pieces, filling the upper part of the interradial areas; *axilliary areas* flat, and each occupied by an hexagonal or heptagonal piece about the size of the second piece of each secondary radial, while the space above is occupied by several much smaller pieces; *arms* 20, 4 to each ray, rounded on the dorsal side, slender, of moderate length, very gradually tapering, simple, and composed of very short, slightly wedge-form pieces, each of which bears a pinnule at its inner lateral end; *pinnules* slender, rather closely arranged, deeply furrowed on the inner side and apparently composed of rather long joints; *surface* of the body plates all ornamented with distinct radi-

ating costæ, starting from the center of each piece, and passing, one to each of its sides, so as to connect with others on each contiguous piece; of these costæ those passing up the middle of each of the radial series are a little larger and more prominent than those of the interradial plates, while they bifurcate with the rays so as to send a division up each of the secondary radial series, toward the upper part of which they become more prominent and rounded, being those about the size of the free arms. (Proc. Acad. Nat. Sci., Phila., for 1872, p. 314; Pal. of Ohio, Vol. I, p. 32.)

Locality.—Cincinnati, Ohio.

Remarks.—A variety was described by Miller in 1878 (Jour. Cin. Soc. Nat. Hist., Vol. I, p. 103), under the name of var. *sublævis*. As the only distinguishing mark was an absence of sculpturing, the founder of the species rightly concluded later on (Ibid, Vol. VI, 1883, p. 217) to abandon it.

3.—G. SUBGLOBOSUS Meek, 1872.

Originally described as a variety of *G. dyeri*, from which it differs by a much stouter body, which is also less rounded below, while the arms and the ridges extending up to the radial and anal plates are stouter; *column*, much thicker; 10 or 12 *secondary radials* between the first bifurcation on each ray to the second division. (Proc. Acad. Nat. Sci., Phila., for 1872, p. 314; Pal. of Ohio, Vol. I, 1875, p. 34, as *G. dyeri* var. *subglobosus*.)

Locality.—Cincinnati, Ohio.

4.—G. FORNSHELLI S. A. Miller, 1874.

Body obconoidal, about 1½ times as high as wide and tapering to the column; *basals* 5, pentagonal, wider than high; *first radials* much larger than basals, heptagonal, nearly as wide as long, inserted in angle produced by two basals; second radials octagonal, as long but not as wide as the first; third radials heptagonal, about the size of the second, each supporting two secondary radials; *secondary radials* 5, first two nearly as large as the primary radials, others much smaller; *interradial* series consists of 1 hexagonal plate in the first range, 2 in the second, 3 in the third; above these

about twenty pieces irregularly disposed in ranges, varying from pentagonal to heptagonal, gradually becoming smaller above; *intersecondary* radial areas, each occupied by about twelve pieces, the first heptagonal, second hexagonal, and above ranges of two each, until near the top, where there are three pieces between the secondary radials; each basal marked with four converging lines on a side; each triangle on the radials marked by parallel lines at right angles to the side of the plate; these lines continue over on the interradial pieces, but never cross each other, the ends being separated by a row of dots; *arms* arise from third secondary radial, and become free on leaving the fifth without bifurcating; consist of round, wedge-shaped pieces, each supporting a pinnule; bifurcate on the twelfth piece, and again and again between the twentieth and fortieth pieces; *pinnules* long, and closely arranged along the inner lateral margins; *column* sharply pentagonal, composed of alternately thick and thin pieces. (Cin. Quart. Jour. Sci., Vol. I, p. 348.)

Locality.—Morrow, Ohio.

Remarks.—A beautifully ornamented species, intermediate between *decadactylus* and *dyeri* in the number of secondary radials, and having the column pentagonal instead of round.

5.—G. MIAMIENSIS S. A. Miller, 1882.

Body proportionally long and very gently expanding, diameter at free arms about two-thirds of length; obconoidal, with interradial and intersecondary radial spaces depressed; *surface* smooth or slightly granular, not sculptured; *basals* well developed, with high projecting angles between the sides of the first primary radials; *first radials* large, about as high as wide, hexagonal, truncated above, central part contracted into a round ridge; second and third radials smaller than the first, about as wide as high, heptagonal, the radial ridge bifurcating in the upper third of the third radial; six or more *secondary radials* form part of the calyx before two arms become free; in another series only 3 secondary radials; number of *arms* unknown, because of the irregularity in those observed, but between 10 and 20; arms long and slender, round on outer side, composed of many cuneiform plates,

4 or more of which are equal in length to the diameter of the arm; *pinnules* long and very slender, and composed of long-jointed pieces; *column* round, of alternately thick and thin pieces. (Jour. Cin. Soc. Nat. Hist., Vol. V, p. 34.)

Locality.—Waynesville, O.

6.—G. SCULPTUS S. A. Miller, 1882.

Body somewhat urn-shaped, nearly as wide as high, sides rounded below; interradial and intersecondary radial areas flattened and slightly depressed; *basals* fairly well developed; two ridges, extending from the center of *first radials* and uniting with the ridges on the basals, expand rapidly; first, second, and third radials heptagonal, slightly wider than long; 3 *secondary radials* in each series, a little smaller than the primary radials; the upper sloping sides supporting 6 or 8 brachial plates before the arms become free; *arms* 20, long, round, composed of cuneiform plates, and with long, slender pinnules; *surface* of plates deeply sculptured. (Jour. Cin. Soc. Nat. Hist., Vol. V, p. 37.)

Locality.—Waynesville, O.

7.—G. SHAFFERI S. A. Miller, 1875.

Body very small, but little larger than the column, with very slight ornamentation; *basals* small, pentagonal; *primary radials* 3×5; radials small, wider than long; third radials support the free arms, and form a longitudinally convex elevation above the interradials; 3 or 6 interradials; *arms* free, cylindrical on the outside, bifurcating on the eighth to the twelfth plats; *pinnules* comparatively large and strong, alternately arranged on inner lateral sides of arms and composed of pieces 3 or 4 times as long as wide; *column* large, composed of alternately thick and thin pieces and tapering to a point, thus being a free floating species. (Cin. Quart. Jour. Sci., Vol. 2, p. 277; Jour. Cin. Soc. Nat. Hist., Vol. III, 1880, p. 233; also Ibid., Vol. VI, 1883, p. 231, as *Pycnocrinus.*) (*Glyptocrinus shafferi* var. *germanus* S. A. Miller. Jour. Cin. Soc. Nat. Hist., Vol. III, 1880, p. 233; *Pycnocrinus germanus* S. A. Miller. Jour. Cin. Soc. Nat. Hist., Vol. VI, 1883, p. 232.)

Locality.— Cincinnati, O.

Remarks.—The variety *germanus* does not seem to differ enough to warrant separate description. Wachsmuth and Springer believe the genus *Pycnocrinus* to be founded on a young specimen, and state that the specimens "referred to *Pycnocrinus* are so embryonic in their condition, that it would be speculation for us to assert to what species they belong." (Review of Palæocrinoidea, Part 3, p. 103.) The fact that the specimens do not seem to have been attached seems to point to an embryonic or immature condition, like the *Comatula* stage of the modern crinoids.

Genus 6.—MARIACRINUS Hall, 1859.

Calyx obconical, with the general aspect and ornamentation of *Glyptocrinus;* radiating striæ pass from plate to plate; *basals* 4, small, of almost equal size, the one facing the anal area largest; *primary radials* 3×5, nearly as wide as high, increasing in size upwards; first set joining laterally; second set inclosing the first anal and first interradial plates; the third set supporting 3×10 *secondary radials*, that are generally of uniform size, and vertically separated by 6 or more interaxillary plates; secondary radials followed by several *tertiary radials*, that vary in number with the age of the individual, 5 or more at times, all placed in a direct line with the arms, and somewhat resembling arm-plates; *arms* 20, 4 to each ray, inner ones branching once or twice, outer ones simple; both inner and outer arms composed of quadrangular single joints, with straight or oblique sutures; arm bearing joints subpentagonal; main arms and branches fringed with pinnules; *interradial areas* large, depressed, and composed of a great number of plates, the first wedged in between the upper sloping sides of two first radials and two second radials; second interradial series consisting of 2 plates, and each succeeding series of 2 or 3; *anal* area wider, the first plate in line with the first interradials, succeeded by three plates in each succeeding series; *vault* composed of very minute, irregular pieces without definite arrangement; *anal* aperture eccentric, opening directly through the vault; *column* (in our species) 4-sided, each side slightly concave; central canal

sub-pentagonal, and of more than medium size. (Pal. of N. Y., Vol. III, p. 104; Wachsmuth & Springer, Review of Palæocrinoidea, Part II. [Proc. Phila. Acad. Nat. Sci. for 1881, p. 115.] *Compsocrinus* S. A. Miller, 1883. Jour. Cin. Soc. Nat. Hist., Vol. VI, p. 233.)

Remarks.—The description above given is the amended one of Wachsmuth and Springer. These writers conclude that *Compsocrinus* is a synonym, and it is so regarded here. The latter genus was made by Miller for the species previously described as *Glyptocrinus harrisi*, which is given below, and which is the only one occurring in our region. The other species referred to the genus are all Upper Silurian.

1.—M. HARRISI S. A. Miller (sp), 1881.

Calyx obconoidal, with flattened interradial, intersecondary, and intertertiary areas; radial ridges strong, and separated at the sutures; *surface* strongly sculptured with star-like ornamentation in relief; *basals* 4, 2 pentagonal and 2 hexagonal, each about twice as wide as high and deeply sculptured; 3 *primary radials* about the same size; 2 *secondary radials* of equal size, and about as large as the primaries; 8 *tertiary radials* in each series, gradually diminishing in size; 20 arms at the vault; plates of the regular *interradial* areas resting upon the first primary radials, followed by 2 plates, and above this by 2 or 3 plates in each range to the top of the vault; *intersecondary* areas, with 1 or 2 plates in each transverse series, the intertertiary plates following each other in single order; first *azygous* plate resting on one of the 4 basals, followed by a series of rather large plates, upon each side of which there are nearly as many plates as in the regular interradial areas; vault unknown; arms with strong pinnules; *column* 4-sided, each side slightly concave, corners rounded. (Jour. Cin. Soc. Nat. Hist., Vol. IV, p. 74, as *Glyptocrinus*: Ibid, Vol. VI, 1883, p. 234, as *Compsocrinus*.)

Locality.—Waynesville, Ohio.

Remarks.—Wachsmuth and Springer have reduced *Compsocrinus* to a synonym, upon the ground that Miller's diagnosis was not exactly correct, and that typical specimens have all the characters of *Mariacrinus*, as emended by them.

[TO BE CONCLUDED.]

ARTICLE XIII.—A STUDY OF THE COPEPODA FOUND IN THE VICINITY OF LINCOLN, NEBRASKA.*

By Albert D. Brewer, A. M.

This study has been thorough only for the spring months and for the immediate vicinity of Lincoln, but includes some forms found at neighboring places in the state. While many collections were made earlier than March, they have been almost entirely neglected, as the collecting apparatus was inadequate to thorough exploration, so that the earlier collections are referred to in one or two instances only. The aim of my study, after identifying the known species and describing two new ones, has been to determine the habitat of the forms present here; unfortunately the results in that line are mainly negative.

The table made to show the occurrence does not by any means represent all of the examinations made, but only the more typical and important ones. Other places than those given will have to be referred to occasionally, however. It will be noticed that the faunas of ponds, located but a short distance apart and apparently similar, differ materially in the species present.

Considering the small locality and limited time during which collections were made, the variety of *Copepoda* seems to be up to the average. It is deficient in species of *Cyclops*, but has a large group of *Diaptomi*. In the latter genus, and to some extent in *Cyclops*, the prevalent forms are those common to stagnant or temporary pools. This is fully justified by the number of such pools found all along the bottoms of Salt Creek and its tributaries during the spring and early summer.

The largest lakes examined were not large enough or deep enough to show a different copepod fauna at their center from that found at the edge, or essentially different from that of the smallest roadside puddle. I suppose this lack of a distinctive pelagic or littoral fauna is due to the fact that all

* Studies from the Zoological Laboratory, The University of Nebraska, Lincoln, under the direction of Henry B. Ward, No. 29.

the lakes are so shallow. The largest lake—a salt lake near Lincoln—is one or two miles long and one-half broad, but its deepest parts are said to be less than eight feet, and this is typical of all. Probably the proper pelagic fauna of other places is due to a constant temperature and food supply that would not exist in these shallow lakes. Yet some of the species of *Cyclops* which, in other localities have been considered strictly pelagic, seem able to stand the greater changes, and are found here in association with strictly stagnant water varieties. For example, *Cyclops leuckarti* and *Cyclops pulchellus* have been found in marshy places in association with *Diaptomus sanguineus* and *Cyclops navus*. To such an extent has this been true that it has been impossible to determine the normal habitat of these species.

In the ponds and lakes subject to the least change during the year, without regard to size, fewer species are found than in those subject to varying conditions of water supply. The place to look for the greatest variety here is in some pond which does not become quite dry at any season of the year, but comes very near it, and which is marshy in its nature.

It is very marked that the least variety occurs in the largest lakes. The two largest had but one variety. Two small ponds, supplied by deep wells, and of some depth, had but two species, while most of the temporary or stagnant pools had four or more varieties. The same rule applies also to the *Cladocera*. The two largest lakes had one or two species, while the marshy ponds might have six or seven. Of course, the pond must last a considerable portion of the year in order to develop a variety.

None of the species, so far as I find, can stand a strong current. Of the millions that must be carried from the slower streams and quieter portions where they abound, none seem to live to reach the larger rivers. I could find none in the Platte, or even in Salt Creek near its mouth, where it is quite large, and has a strong current. Wherever there are many specimens in a stream, with even a slight current, it is usually found that they have been washed from some quiet pond near at hand.

The coloring of the specimens taken from the quiet, stagnant water is much more brilliant than that of those found

in the streams, or in clear water where the vegetation is slight. The coloring indicates nothing so far as identification of species is concerned. Even *Diaptomus sanguineus*, which is usually such a brilliant red, I found twice without the slightest coloring. On the same day in adjacent pools were found specimens of *Cyclops americanus* beautifully colored, those from one pool red with blue ovisacs, and those from the other blue with red ovisacs. From a third pool the specimens were all a handsome green from a protozoan which covered them.

The three genera of the locality belong to different families and are immediately distinguishable. The *Diaptomi* have long antennæ with more than twenty joints. The body nearly cylindrical, with a sharp constriction at the beginning of the abdomen. The caudal furca bearing five nearly equal setæ and a sixth inner smaller one. The *Cyclopes* have shorter, stronger antennæ, with from ten to seventeen joints, a tapering body, and a distinct constriction at the beginning of the abdomen. The caudal furcæ are long, and bear two long setæ (or three) with four others less developed. The *Canthocampti* have eight-jointed antennæ, slightly tapering body, with no constriction between the thorax and abdomen. The caudal furcæ bear one seta much longer than any other.

KEY TO THE SPECIES OF DIAPTOMUS FOUND.

A. The antepenultimate segment of the male right antenna unarmed.

1. The inner ramus of the male right fifth foot equal to the first joint of the outer. *pallidus.*
2. The inner ramus of the male right fifth foot much shorter than the first joint of the outer ramus. *nebraskensis* n. sp.

B. The antepenultimate joint of the male right antenna bearing a short hook.

1. The inner ramus of the male left fifth foot longer than the first joint of the outer ramus.
   a. The basal joint of the right foot produced and sometimes jointed at the outer distal angle. *sanguineus.*

b. The first joint of the outer ramus bearing a projection on its inner side beyond the inner ramus. *siciloides.*

2. The inner ramus of the left fifth foot not so long as the first joint of the outer ramus. *saltillinus* n. sp.

C. The antepenultimate joint of the male right antenna bearing a hook longer than the following segment. eiseni.

Diaptomus pallidus Herrick.

A rather small species, measuring scarcely a millimeter in length. It is broadest at its third segment.

The first segment is two-fifths of the cephalo-thorax, the other segments being nearly equal. The last bears two minute teeth. The first abdominal segment of the female is a little longer than the two remaining segments and dilated anteriorly. The last is a little longer than the second, and split for half its length. The furcæ are ciliated on their inner aspect, and are slightly longer than broad.

The antennæ reach to the end of the furcal setæ.

The basal joint of the fifth foot of the female is triangular. The inner margin of inner ramus bears several small hairs, and at the inner side of the tip are two curved spines, one about twice the length of the other. The first joint of the outer ramus is not quite as long as the inner ramus. The claw is well curved, and is much narrowed beyond the point where the spines arise on the outer aspect.

The antepenultimate joint of the right male antenna bears no armature of any kind. It is not much swollen proximally to the geniculating joint.

The right fifth foot of the male is long and slender. The inner ramus is a little longer than the first joint of the outer ramus. The terminal joint is elongated, and bears a slight notch at its second third on the inner aspect. The slightly curved claw is nearly regular. It is marked by very fine teeth. The accessory spine is close to the claw, is small and curved inward.

The basal joint, inner ramus, and the first joint of the outer ramus of the left foot are nearly the same in length as the corresponding parts of the right foot. The terminal joint bears

exteriorly at the tip a finger-like projection, roughened on its inner surface. Curved toward this, from the inner part of the tip, is a spine very slightly plumose. The inner ramus of both feet are covered with very short hairs.

This species was found at Louisville in ponds made by the removal of sand. It was found on both sides of the Platte in similar places. The water was clear and deep with little vegetation. The species is said to be littoral.

DIAPTOMUS NEBRASKENSIS n. sp. (Figs. 1–4.)

A rather large species, the female varying from 2.25 mm. to 2.5 mm. in length and the male being a little smaller. The cephalo-thorax is considerably broadest in the middle. The first segment is nearly half the cephalo-thorax. The last two segments of the female are fused. The last segment is asymmetrical in the male and still more so in the female, the left side being produced further back (Fig. 4). There is a small tooth at the exterior angle in the female.

The first abdominal segment of the female equals the rest of the abdomen and furca. It bears small lateral teeth. The second segment is about half the length of the first and the third very short. Caudal furcæ a little longer than broad. The spermatophores were frequently attached to the specimens, and usually there were two or more, sometimes as many as six. The egg sac contains an unusually large number of eggs.

The antepenultimate segment of the male right antenna is unarmed (Fig. 1). The joint proximal to the geniculating joint is not much swollen.

The basal joint of the right fifth foot in the male (Fig. 3) bears a tubercle at the middle of the inner margin and a spur at the inner proximal angle. The inner ramus is small and hardly half the length of the first joint of the outer ramus. The prominent characteristic of the species is a strong claw borne on the back side of the basal joint, twice the length of the inner ramus. The terminal joint is nearly rectangular, with the accessory spine at the outer distal angle, and a regularly curved terminal claw at the inner. The claw is dentate more than half its length.

The left foot reaches to the terminal joint of the right foot. The inner ramus is club-shaped, bent toward the outer ramus, and reaches to about the middle of the terminal joint of the outer ramus. Its tip bears four or five small spines. The two joints of the outer ramus bear numerous fine hairs on their inner aspect. The terminal joint bears a seta plumose on one side and a short spearhead-shaped projection.

The inner ramus of the fifth foot of the female (Fig. 2) is of small caliber and about as long as the outer ramus. It bears two serrate spines of nearly half its own length and three or four very small spines. The terminal claw is dentate on both margins, and bears on its posterior margin two small bare spines and a longer serrate one.

Types are deposited in the U. S. National Museum, in the Museum of the Cincinnati Society of Natural History (Acc. Cat. No. 15,000), and in the zoological collection of the University of Nebraska, Lincoln.

Whether this species is one which appears only temporarily in the spring I can not tell. It appeared usually in temporary pools. I found mature ova-bearing specimens April 10 and June 3. I think it may stay the year round under favorable circumstances.

Diaptomus sanguineus Forbes.

A species of small or medium size. The first segment is equal to the remainder of the cephalo-thorax. The outer segments are nearly equal. The last segment in the female is armed with an unusually strong spine at its outer angle.

The first abdominal segment in the female equals the rest of the abdomen and furca. It is armed with strong lateral spines about one-third of the length of those on the last segment of the cephalo-thorax. The second segment is about one-half as long as the third. The furcæ are longer than broad, and may be ciliated on their margins. The antennæ reach to the middle of the furca.

The fifth foot of the female is short and thick. The inner ramus is scarcely two-thirds of the length of the first joint of the outer. It bears two spines half its own length. The claw is well curved and dentate along its inner aspect. On

the outer aspect are two spines, one twice the length of the other, and half the length of the claw.

The antepenultimate joint of the male right antennæ is armed with a hook shorter than that of *D. siciloides.*

The basal joint of the male right fifth foot is large, and produced at its distal outer angle into a strong spine. This spine is usually separated from the basal segment by a joint, but I think not always. The inner ramus is much reduced, about equaling in length the spine just mentioned. The terminal joint is long and slender. The accessory spine is slightly nearer the distal end of the segment. The claw is not much curved, and is dentate for half its length.

The basal segment of the left foot is nearly square. At the outer distal angle there is a small seta. The inner ramus is longer than the first joint of the outer ramus and unarmed. The terminal joint bears a finger-like process and curved ciliate spine opposed to it. On its inner aspect is a nearly hemispherical hairy pad. The left foot does not reach to the end of the basal joint of the right foot.

This species appears for a short time only in the early spring in stagnant water.

Diaptomus siciloides Lilljeborg.

The smallest species of the genus in the locality and one of the smallest anywhere found. It measures less than a millimeter, but varies somewhat according to its environment. The first segment is two-fifths of the remainder of the cephalo-thorax. The others are equal up to the last, which is somewhat shorter, and bears two small teeth on its exterior angle.

The first segment of the abdomen more than equals the last two and furca. It bears a small lateral tooth. The second segment is about one-third of the last. The furcæ are longer than broad, and are ciliated on their inner margin.

The antennæ reach nearly to the ends of the furcal setæ.

The male antennæ are not strongly geniculate. The antepenultimate joint of the right antenna bears a hook longer than that of *D. sanguineus* or *saltillinus.* It is nearly half as long as the following joint.

The species is recognized readily by a projecting knob on the inner margin of the first joint of the outer ramus of the male right fifth foot. The inner ramus is half as long as the first joint of the outer. Half its length is covered with fine hairs. The accessory spine is at the last third of the terminal joint. The terminal claw is regularly curved, and without dentition.

The basal joint of the left foot is produced in the direction of the inner ramus, which reaches the middle of the terminal joint of the outer ramus. The two joints of the outer ramus are ciliated on their internal aspect. The end of the terminal joint is covered with fine teeth. It bears two short blunt processes, one at the tip, the other at the last fourth interiorly.

The inner ramus of the fifth foot of the female has a pointed tip covered with fine hairs. At the inner side of the tip are two curved spines or setæ one half the length of the other. The terminal claw is not much curved, but is dentate on the inner margin, and sometimes on the outer.

This species is found everywhere about here by itself or in association with any of the other forms, in large lakes and stagnant pools, and at all times of the year.

Diaptomus saltillinus n. sp. (Figs. 5–9.)

The species is of medium size and quite slender. Its first segment equals about two-fifths of the cephalo-thorax. The following are not quite equal to each other, but gradually decrease in length to the last.

The female has a broad short spine in the middle of the back of the next to the last segment of the thorax, which serves to easily distinguish the species. The last segment is distinctly asymmetrical, the left side projecting back and out further than the right. There are small spines, outwardly directed, at both the inner and outer angles of the projecting part.

The first abdominal segment of the female (Fig. 7) is as long as the two following and the furca. It bears small lateral spines on the second fourth. The second segment is very

short, the last being somewhat longer, and about as long as the furca. The furcæ are longer than broad, and are ciliate along the inner aspect.

The antennæ reach to the end of the furca.

The fifth foot of the female (Fig. 8) has a nearly triangular basal joint, which bears a seta at its outer angle. The inner ramus is short and stout, bearing minute spines at its tip.

The terminal claw has eight or ten strong teeth on its inner aspect, and a few smaller ones on the outer edge. The third joint is represented by two small spines and a short seta.

The antenna of the male (Fig. 6) is much swollen, and bears an unusually strong spine on the first swollen joint. It is not as long as the antennæ of the female. The antepenultimate joint bears a short hook like that of *sanguineus*.

The basal joint of the male right fifth foot (Fig. 5) bears a small tubercle at the middle of its inner aspect. The seta on the outer edge is short. The inner ramus is shorter even than the very short first joint of the outer ramus. It bears a few small teeth at its tip. The accessory spine is close to the terminal claw, and is unusually long. The claw is bent at its middle to nearly a right angle. The first half bears fine teeth.

The left fifth foot reaches a little beyond the first joint of the outer ramus of the right. The basal joint has a tubercle which nearly meets that of the right foot. The inner ramus is like that of the right foot. The two joints of the outer ramus bear hairy pads on their inner aspects. The terminal joint bears a short curved spine and a short finger-like process.

The female measures 1.5 mm., the male 1.25 mm. in length.

Types are deposited in the U. S. National Museum, in the Museum of the Cincinnati Society of Natural History (Acc. Cat. No. 15,001), and in the zoological collection of the University of Nebraska, Lincoln.

This species has been found principally in temporary pools. It was found once in the late fall in a small constant pond, but was not there early in the spring. It probably appears, like *Diaptomus sanguineus*, in the spring and fall only, following that species often.

Diaptomus eiseni Lilljeborg.

Perhaps this should be considered a separate species or variety, but it shows such marked resemblances, and I have found so few specimens on which to base a description, that it seems best not to separate it from the known form. It is by far the largest species found near here, and is scarcely equalled anywhere. The female measured 4.5 mm., and the male 4 mm. in length.

The first segment equals two-fifths of the whole length of the cephalo-thorax. The others are nearly equal, except the last, which is much shorter. It bears two small teeth at its outer angles.

The abdomen of the female is slender (Fig. 12). Its first segment is equal to the rest of the abdomen and furca. It bears quite prominent lateral teeth. It is very slightly dilated anteriorily. The third segment is three times as long as the second. The furcæ are longer than broad and are ciliate along both margins.

The antennæ of the female, which are a little shorter than those of the male, reach only to the middle of the first abdominal segment.

The basal joint of the female fifth foot (Fig. 11) is nearly triangular, and bears a seta at the outer angle. The inner ramus is very slender, and is terminated by two spines, one-third to one half its own length. Including these spines it still does not quite equal the first joint of the outer ramus. The terminal jöint of the outer ramus bears several teeth at the inner edge, a plumose seta and two small spines on the outer.

The antepenultimate joint of the male right antenna (Fig. 10) bears a hook as long as the last two joints and exactly like that of the type. On the middle of the joint opposite the hook is a peculiar seta, jointed at its middle, and at the same time suddenly reduced in size.

The basal joint of the right fifth foot of the male (Fig. 9) is roughened on its inner aspect. The inner ramus is small and about equal in length to the first joint of the outer ramus. That joint is produced a little at its outer distal angle and bears a small tubercle on its inner aspect. The terminal joint bears a strong bent serrate spine at its distal third. The claw

is sharply bent to almost a right angle. Its tip is bent backward a little. The claw is very finely serrate.

The right foot and claw is usually bent round the left foot, which reaches to about the second third of the terminal joint of the right foot. The inner ramus of the left foot reaches the middle of the terminal joint of the outer ramus. Both of the terminal joints of the outer ramus are hairy on their inner aspects. The terminal one has a curved spine on the inner face and a small blunt projection at its tip.

This species was found but once. It was present in a temporary very shallow pool which covered half an acre. The greatest depth of the pond was not more than two feet. It was found there April 24 and May 15, but had disappeared May 29, when the water had become so shallow that the Birge net could hardly be used.

Key to the species of Cyclops found.

A. Antennæ 17-jointed.

a. Fifth foot two-jointed, basal joint longer than broad. *signatus.*

b. Fifth foot two-jointed, basal joint nearly square. *leuckarti.*

c. Fifth foot two-jointed, basal joint broader than long.

1. Terminal joint bearing a long seta and very short spine. *americanus.*
2. Terminal joint bearing two setæ, and nearly three times as long as its breadth at the base. *navus.*
3. Terminal joint bearing two setæ, and not twice as long as its breadth at base. *pulchellus.*

B. Antennæ 12-jointed.

a. Furca armed externally with small spines. *serrulatus.*

b. Furca shorter and not so armed. *fluviatilis.*

Cyclops signatus Koch.
(tenuicornis and coronatus Herrick).

The largest species of *Cyclops* found here. It varies from 1.4 mm. to 1.8 mm. Its structure is well known. The first

segment is more than half the cephalo-thorax, and is broad and thick in front, the greatest width being about the middle of this segment. The antennæ are seventeen-jointed, tapering from the broad first joint to the last two, which are four times as long as broad. The fifth foot is two-jointed, each longer than broad. The first bears a ring of fine spines near its base and a row near its distal end. It bears a very small seta, plumose only near the end. The second joint bears two serrate spines laterally and medianly a seta, plumose at the tip, like that of the first joint.

The abdomen is short and thick. The last three segments are not as long as the preceding. The furcæ are short, but nearly as long as the two preceding segments, or twice their own breadth. The setæ are closely plumose. The median setæ are as three to four.

The two varieties, *coronatus* and *tenuicornis*, I have found together, but *coronatus* is always in small numbers. In one case *tenuicornis* was alone. The real differences between them are confined to the seventeenth joint of the antenna and the caudal setæ. The fifth feet are alike to the minutest detail, and the difference between their first cephalo-thoracic segments and their furcæ is hardly distinguishable. The last antennal joint bears a serrate hyaline plate in *coronatus* and not in *tenuicornis*. In *coronatus* the caudal setæ from the inner out are to each other as 2:4:3:1; in *tenuicornis* as $2:4:3:\frac{1}{2}$.

The armature for the terminal joints of the swimming feet for both is as follows:

		Outer ramus.	Inner ramus.
First foot....	ex.	3 spines	1 seta.
	ap.	1 spine, 1 seta	1 spine, 1 seta.
	in.	3 setæ	3 setæ.
Second and Third feet...	ex.	3 spine	1 seta.
	ap.	1 spine, 1 seta	1 spine, 1 seta.
	in.	4 setæ	3 setæ.
Fourth foot..	ex.	2 spines	1 seta.
	ap.	1 spine, 1 seta	2 spines.
	in.	4 setæ	2 setæ.

Though this species is not marked as appearing many times on the table, yet I found it in a good many places always in small numbers. It was commonest in the deepest pools.

CYCLOPS LEUCKARTI Sars.

This is a large species and the most variable in size. Specimens collected at the same time and place may vary from 1 mm. to 1.5 mm. Herrick gives the variation as from 0.5 to 1 mm., a marked difference in size. The specimens found here agree most closely with his "deep-water variety." The species is quite slender, the cephalo-thorax not being as distinctly marked off from the abdomen as is usual. The first segment is equal to half the cephalo-thorax and almost equal to the abdomen. The last three segments of the abdomen are pectinate posteriorly. The caudal furcæ are strongly divaricate, and nearly equal in length to the two preceding segments. The lateral spine is at the end of the third fifth. The species is most readily recognized by the three well-developed setæ. The inner terminal seta is two-thirds the length of the inner median, and the two median are nearly equal. These three setæ, in rare individuals, are so closely plumose as to give something the appearance of the setæ of a *Diaptomus*. These individuals can be readily recognized by the naked eye.

The fifth foot is two-jointed. The first joint is nearly square and bears a short plumose seta. The second joint bears on its inner side a long seta serrate on one side, and at its tip an equally long seta plumose for its last third. The antenna is seventeen-jointed and reaches the middle of the third segment. The terminal joint is armed with a toothed hyaline plate. These teeth become plain only with high power.

The armature of the terminal joints of the swimming feet is as follows:

		OUTER RAMUS.	INNER RAMUS.
First foot....	ax.	2 spines	1 seta.
	ap.	2 setæ	1 spine, 1 seta.
	in.	2 setæ	3 setæ.
Second and Third feet....	ex.	2 spines	1 seta.
	ap.	1 spine, 1 seta	1 spine, 1 seta
	in.	3 setæ	3 setæ.
Fourth foot...	ex.	2 spines	1 seta.
	ap.	1 spine, 1 seta	2 spines.
	in.	3 setæ	2 setæ.

The apical spines of the fourth foot are equal in length. The outer ramus of the first foot is so shortened as only to reach the last joint of the outer ramus. The last of its spines considered lateral is practically apical.

It has been considered pelagic, and I have oftenest found it in the deeper pools of clear water, but, with some marked exceptions, the principal one being a marshy pond three miles east of Milford. It is widely distributed and quite common.

Cyclops americanus Marsh.

This is a large species of about 1.3 mm. The first segment is half of the cephalo-thorax. The first segment of the abdomen equals the remainder. The last segment is dentate posteriorly. The furcæ are about five times as long as broad. The lateral spine is at the last fifth. The median setæ are as three to four.

The antennæ reach the second segment.

The fifth foot is two-jointed, the first being very broad. It bears a long plumose seta. The second joint bears a very short spine laterally and a long seta. Both joints are rounded in their outline.

The armature of the terminal joints of the swimming feet is as follows:

		Outer ramus.	Inner ramus.
First foot	ex.	3 spines............	1 seta.
	ap.	2 setæ..............	1 spine, 1 seta.
	in.	2 setæ..............	3 setæ.
Second and Third feet....	ex.	3 spines............	1 seta.
	ap.	1 spine, 1 seta......	1 spine, 1 seta.
	in.	3 setæ..............	3 setæ.
Fourth foot...	ex.	3 spines............	3 setæ.
	ap.	1 spine, 1 seta......	2 spines.
	in.	3 setæ.......	2 setæ.

This species is by far the commonest copepod near here. Every little pool, even if it has only known a few days' existence, will be swarming with them. I have hardly found a place where they were not present, and more than half the time they are the most abundant form. They have no typical color, but in most of my collections are red, or blue and red.

Cyclops navus Herrick.

This form is considered a variety of *C. pulchellus*, by Herrick, but given specific value by Marsh. It seems quite distinct in habitat and form. It is slenderer than *C. fuscus* or *C. leuckarti*, but nearly the same length. The first segment is less than half of the cephalo-thorax. The second segment is shorter than the third. The first abdominal segment is a little longer than the two following. All the abdominal segments are dentate on their posterior margins. The furcæ are four times as long as broad. The lateral spine is at the end of the second third, and is plumose. The two median setæ are nearly equal, the first and fourth are as 3 : 2. The seventeen jointed antennæ reach to the middle of the second segment. There is, on the first joint, a transverse row of very fine teeth. The fifth foot is two-jointed. The first joint is broader than long, and bears a plumose seta. The terminal joint is much elongated, and broadest at its distal end. It bears a plumose seta and smooth spine half as long as the seta.

The armature of the terminal joints of the swimming feet is as follows:

		Outer ramus.	Inner ramus.
First foot...	ex.	2 spines..........	.....1 seta.
	ap.	2 setæ...........	......1 spine, 1 seta.
	in.	2 setæ	3 setæ.
Second and	ex.	2 spines................	1 seta.
Third feet..	ap.	1 spine, 1 seta..........	1 spine, 1 seta.
	in.	3 setæ	3 setæ.
Fourth foot.	ex.	2 spines................	1 seta.
	ap.	1 spine, 1 seta..........	2 spines.
	in.	3 setæ............	.....3 setæ.

This form was found twice beside at the place mentioned in the table, each time in marshy shallow ponds.

Cyclops pulchellus Koch.

A slender species 1.25 mm. long. Broadest at about the middle of the first cephalo-thoracic segment. Somewhat

smaller than *C. navus*, which it resembles in the form of the abdomen. The first segment is about three-fifths of the whole cephalo-thorax. The second is shorter than the third. The first abdominal segment equals the rest of the abdomen. The furca are nearly as long as the three preceding segments, and six or seven times longer than broad. The lateral spine is at the last fifth. On the outer margin at the second fifth are several minute spines. This point most readily characterizes the species. The median setæ are as two to three. The first and fourth are short and nearly equal.

The antennæ are seventeen-jointed, and a trifle longer than the first segment. The fifth foot is two-jointed, the first joint being broader than long and bearing a long seta. The second joint is a little longer than broad, and bears one short strong seta and another nearly four times as long. This form can be distinguished from that of *C. navus* by the greater elongation of the furca and the notched appearance on their outer margin, due to the small spines.

The armature of the terminal joint of the swimming feet is the same as that of *C. navus*.

The species is commonest in clear deep water, and is probably pelagic. It is not very widely distributed, but is usually abundant where it appears at all.

Cyclops serrulatus Fischer.

This species measures a little over 1 mm. The cephalothorax is compact. The posterior margin of the last segment is armed, laterally, with fine spines. The abdomen is slender and long, the first segment being dilated anteriorly.

The antennæ are twelve-jointed. The last joints are increasingly long and slender to the last, which is about as long as wide. They reach nearly to the third segment.

The caudal stylets are about five and a half times as long as wide. Their outer margin is armed with numerous small spines. The last segment of the abdomen is dentate posteriorly. The outer furcal seta is replaced by a strong spine, serrate on its outer margin, and plumose interiorly. The median setæ are as 2 : 3.

The fifth foot is one jointed. It bears a seta on its outer side, a terminal seta, and a strongly serrate spine on its inner side.

The armature of the feet is not necessary for the identification of this form, as there is no other form resembling it which has different armature. All the spines are very strongly serrate.

This species is widely distributed and numerous, but not nearly as common as *C. americanus*. The variety, *elegans*, seems to be quite distinct. I have found the two together only once or twice, though they are both quite common.

It differs from the type in the greater elongation of the antennæ, the first cephalo-thoracic segment, furca, and median furcal setæ. The antennæ reach the fourth segment and are stronger than those of the type. The furcæ are eight times as long as broad. The long caudal setæ may make the species 2 mm. The setæ are more closely plumose, or rather spinous than in any other species.

CYCLOPS FLUVIATILIS Herrick.

One of the smallest species in the genus. It is easily recognized by its twelve-jointed antennæ, which reach nearly to the abdomen. The striking characteristic of the female antennæ is the elongation of the seventh, eighth, and ninth joints, particularly the eighth. The appearance of the antennæ justifies Herrick's comparison to the *Diaptomi*.

The first segment is considerably more than half of the cephalo-thorax. The last thoracic segment is narrower than the first abdominal. The abdomen is slender and the furca very short, being only a little longer than the last abdominal segment. The two median furcal setæ are equal, or as 4 : 5.

The fifth foot is one jointed and shaped much like that of *C. serrulatus*. It bears three setæ. While in almost every other particular the species agreed with Herrick's description and drawings, the form of the fifth foot was entirely different. I could not see that the setæ were plumose or serrate, while Herrick makes them very distinctly so.

The ovisac usually contains only five or six ova.

The swimming feet, like the antennæ, resemble the same in the *Diaptomi*. Their armature is as follows:

		Outer ramus.	Inner ramus.
First foot.....	ex.	3 spines............	1 seta.
	ap.	2 setæ..............	1 spine, 1 seta.
	in.	3 setæ..............	3 setæ.
Second and	ex.	3 spines............	1 seta.
Third feet....	ap.	1 spine, 1 seta......	2 setæ.
	in.	4 setæ..............	3 setæ.
Fourth foot...	ex.	2 soines............	1 seta.
	ap.	1 spine, 1 seta......	2 setæ.
	in.	4 setæ.......	2 setæ.

This differs from the armature, as given by Herrick, in having, instead of two setæ apically on the inner ramus of the first foot, a spine and seta. In the same place on the fourth foot I have found two setæ instead of a spine and seta.

This species is very abundant where it is found, but I have found it only three times near Lincoln. Near Grinnell, Iowa, it is one of the most abundant forms. It is said to be pelagic.

Canthocamptus minutus Mueller.

Antennæ eight-jointed, the first four bearing numerous setæ. The antennæ about equal in length to the first thoracic segment. The first segment is marked by a depressed area dorsal and median said to be sensory. The remaining segments of the thorax decrease in length, and are much shorter than the abdominal segments. The whole surface of the body, but more especially of the abdomen, is ornamented with fine teeth. On the abdomen the most conspicuous are a lateral row on the posterior margin of each segment.

The abdomen is not separated from the thorax by any deep constriction and the first abdominal segments are broader than the last thoracic. The furcæ are small and about two and one-half times as long as their greatest breadth. Each bears one terminal seta more than twice the length of the second, and several shorter ones.

Both rami of all the swimming feet are three-jointed.

The fifth foot is two-jointed. The first joint is twice as broad as long, and bears five strong plumose setæ and one very small one on the inner side of the second joint and one

smooth seta at the outer side. The second joint bears four small setæ and one long one.

The species is widely distributed and fairly abundant, though a little hard to obtain — as when the Birge net is drawn close enough to the ground to get the forms, a large proportion of dirt is obtained. They prefer marshy ponds, and only once—at Louisville—have I found them in any clear deep water.

CANTHOCAMPTUS ILLINOISENSIS Forbes.

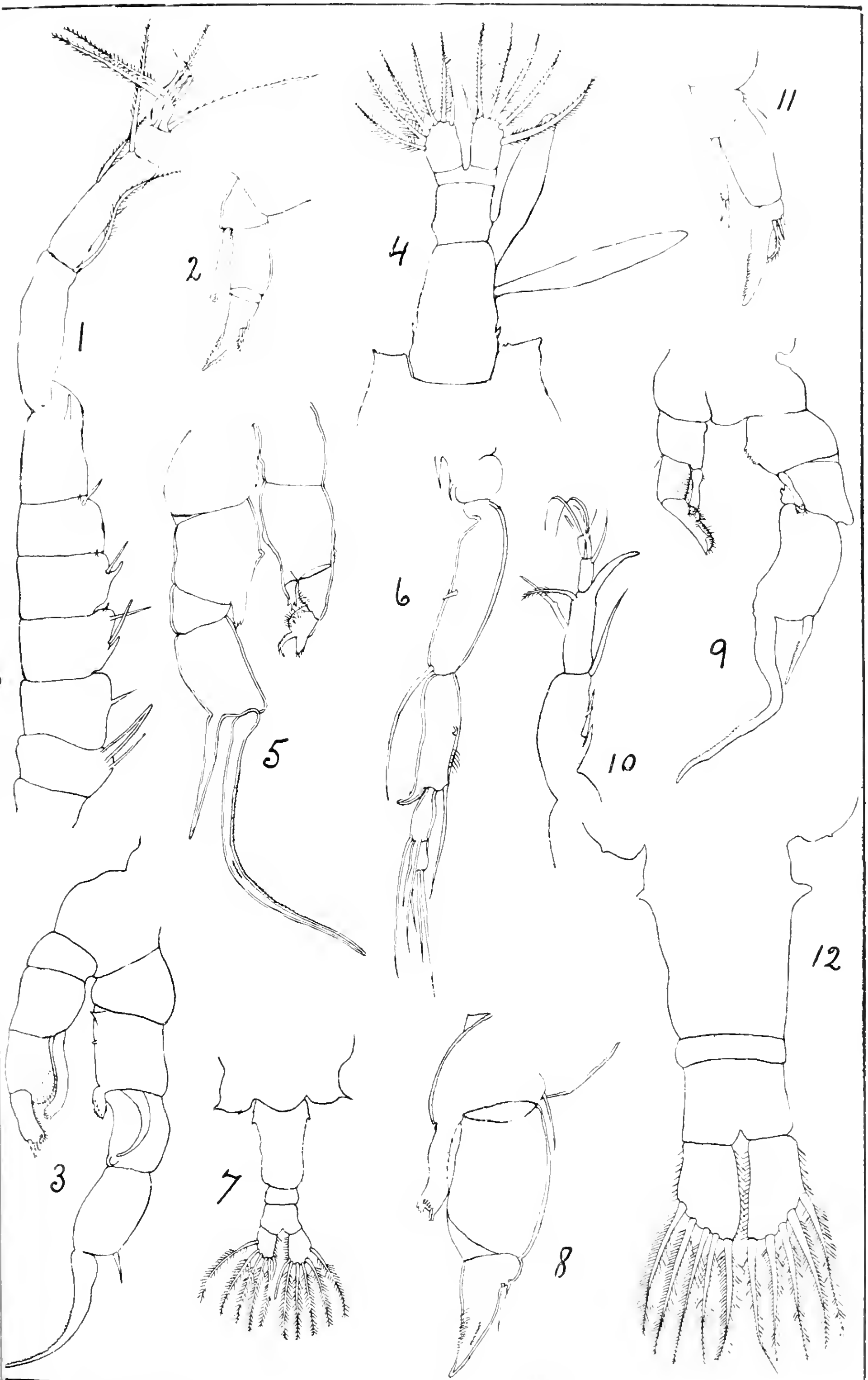
One specimen, which was identified as this species, was found near Saltillo. When a second examination to obtain more was made the pond had dried. The drawings made and all appearances agreed with the description given by Forbes, but the species can hardly be reviewed from a single specimen.

EXPLANATION OF PLATE VII.

Fig. 1.—	Diaptomus	nebraskensis	Antenna of male	× 216
" 2.—	"	"	Fifth foot of female	× 376
" 3.—	"	"	" " male	× 216
" 4.—	"	"	Abdomen of female	× 108
" 5.—	"	saltillinus	Fifth foot of male	× 216
" 6.—	"	"	Antenna of male	× 376
" 7.—	"	"	Abdomen of female	× 108
" 8.—	"	"	Fifth foot of female	× 376
" 9.—	"	eiseni	Fifth foot of male	× 108
" 10.—	"	"	Antenna of male	× 216
" 11.—	"	"	Fifth foot of female	× 108
" 12.—	"	"	Abdomen of female	× 60

Table A.

D. sanguineus	D. pallidus	D. siciloides	D. saltillinus	D. nebraskensis	D. eiseni	Canthoc. illinoisensis	Canthocamptus minutus	C. sign. var. tenuicornis	C. signatus var. coronatus	C. fluviatilis	C. navus	C. pulchellus	C. leuckarti	C. serrulatus var. elegans	C. serrulatus	Cyclops americanus	Locality.
																	Ashland.
							×									×	Louisville.
							×									×	Weeping Water.
																	Milford, ½ mile east of depot.
													×				Blue River, at Milford.
×											×		×				Three miles east of Milford.
		×												×		×	DeWitt.
		×														×	Salt Creek.
												×		×		×	Roca, west of Depot.
		×	×									×				×	E. of Saltillo station, few yds.
			×												×		West of Saltillo, few rds
			×													×	27th St., two miles S. of O St.
×												×				×	Southwest angle of R. I. and B. & M., 2 mi. S. of Peniten.
													×			×	Across R. I. from above, between the B. & M., & U. P.
×		×	×	×	×		×									×	East of B. & M., 1 mi. S. of Pen.
				×													Across B. & M. from above.
		×								×						×	Pond across B. & M. from a pumping sta. in S. Lincoln.
		×		×												×	Northwest of Salt Lake.
																×	Salt Lake.
		×											×				West of packing house.
×		×													×		½ mi. N. E. of old mill on Salt Creek cut off, N. of Lincoln.
		×		×											×	×	At the crossing of 1st wagon-road, E. of F. E. & M. V., and B. & M. with B. & M.
																×	3 miles E. of Univ. Place.
				×												×	Pond N. of Salt Creek, and N. W. of Havelock.
×									×								Waverly, near road north of town, ½ mile.
		×		×									×				Waverly lakes.
								×						×		×	8 miles E. of Havelock.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ARTICLE XIV. — COLEOPTEROLOGICAL NOTES — FAUNAL CHANGES IN THE VICINITY OF CINCINNATI, OHIO.

BY CHARLES DURY, AVONDALE, CINCINNATI.

Fifteen years ago many rare and interesting species of Coleoptera were secured in the immediate vicinity of Cincinnati, and even within the city limits. The destruction of forest trees and the denudation of hill-sides has converted the former beautiful woodland into sterile clay-banks, the rains washing down the rich black soil, cutting the surface into gulleys and ditches. The poor soil remaining only supports briars, thistles, and weeds. This is particularly the case across the Ohio River among the Kentucky hills. The collector is now obliged to go a much longer distance and is very limited in the area of collecting grounds. The most prolific season of the year is from May 25 to July 1. A sandy flat, near Newport, swarmed with *Cicindela cuprascens* and *formosa*, with an occasional specimen of the form *generosa*. Out of a honeycombed log about twelve feet long I chopped over twenty of the pretty blue *Cychrus andrewsii*. *Cychrus heros* occurred on a hill-side of limited area, along the edge of a woods. The late Mr. Siewers trapped twenty-five, by placing flat stones and bits of bark on the ground, under which the beetles took refuge. He pinned them on a board, and placed them in the oven of the cooking stove to dry. (It is needless to say he forgot them, and they were roasted brown!) Lower Mill Creek, once a clean and beautiful stream, is now a vile, open sewer, destitute of animal life. The banks of this creek produced three species of *Omophron*. One day I bottled 365, all washed out of a low sandy bank, about fifty feet in length. Of these 180 were *tessellatum*, 147 were *robustum*, and 38 *americanum*. Associated with *Omophron* were *Heterocerus* and *Carabidæ* by hundreds. Every suitable pool of water was swarming with aquatic beetles of many species. The underside of beech logs, on which was a growth of fungi, produced the curious little *Staphylinid*, *Megalops cœlatus*. *Oxyporus* of four species were to be found cutting burrows through the tender parts of *Agaracinæ*. Many of the beetles usually regarded as rare have a local metropolis,

if it can only be found, where they occur more or less abundantly. An example of this has recently come to light in the case of a little *Pselaphid*, called *Rafonus tolulæ*. One was taken years ago and sent to Le Conte, who said: "I only know of one other imperfect specimen." August 1, 1897, Mr. Soltau took seventy specimens from the crumbling inside of a decaying log. In the nests of a pale ant I found **Adranes lecontei* and *Ceophyllus monilis*, the latter common, the former rare. *Leptinus testaceus* is a curious little pale, blind beetle, that lives in the nests of field mice. December 13, 1891, I captured 112 (ninety of which were taken from one nest). From a large *Agaricus* I captured five *Necrophilus pettiti* Horn. Five species of *Liodes* were taken from under the bark of a beech log on which fungi were growing. From under the bark of a dead buckeye tree one specimen of *Chevrolatia amœna* was taken, and though I have diligently searched like situations for years, I never found another. That unique is in the collection of the late Dr. Horn.

A single specimen of *Cyparium flavipes* was all that has rewarded a search of many years. The locality was very rich in *Endomychidæ*, *Tritomidæ*, *and Erotylidæ*. The original locality for *Megalodacne ulkei*, across the river, being obliterated by the "cultivation" before alluded to, I have discovered another small locality on the Ohio side of the river. Of *Colydiidæ* a number of interesting species have been found; chief of these is *Eudesma undulata* Mels. July, 1878, Mr. Siewers took one from under the bark of a sycamore tree. Since then I have taken six specimens that were running along the underside of a buckeye tree that had fallen across a ravine.

The *Coccinellidæ* were richly represented. *Coccinella affinis* was taken August 7, 1895, for the first time; since then others were captured. This seems to be a recent importation.

The *Scarabæidæ* are not nearly as abundant as formerly, particularly the larger species. *Dynastes* (always rare) I have not heard of for years. *Lachnosterna* was always abundant. I have beaten from the foliage of a small haw, growing in a thick woods, twenty *L. albina* (May 24). The *Buprestidæ* are also getting scarce. *Buprestis rufipes*, our most showy species,

*See note on this species, this Journal, July, 1884.

is now seldom seen. Many fine *Elaters* have been taken. Those of the sub-family *Eucneminæ*, once so numerous, are getting scarcer each year. Of *Melasis pectinicornis* I took fifty specimens from a small beech log.

A dozen *Stethon pectorosus* rewarded an examination of the underside of a decaying poplar log, on which fungi were growing. I never found any more. Of *Corymbites copei* I found but one. The *Ptinidæ* were richly represented, as were the *Spondylidæ*. Of the latter family *Parandra polita* is the most desirable. I chopped three from a dead beech. The *Cerambycidæ* were abundant and of many species. The beautiful *Dryobius sexfasciatus*, once numerous on the dead beech and maple trees, is now much less abundant. Of the rare *Xylotrechus nitidus*, but three specimens have been taken. The *Chrysomelidæ* are richly represented, some of the species entirely too much so. Of the *Tenebrionidæ* I was surprised to secure several *Strongylium crenatum* beaten from dead haw. The new *Melandryid, Mallodryia subænea* Horn* was abundant, living on the branches of dead haw trees. Of the *Mordellidæ* I have† listed fifty-three species with others not yet identified. The *Meloidæ* were never very numerous. April 27, 1891, I shot a king-bird from whose throat emerged a male *Pomphopœa ænea* that the bird was in the act of swallowing, and from the bird's gizzard I secured another (the female). These are the only ones of this species I ever obtained here.

The "Weevils," so-called, were numerous. *Acalles carinatus* is found (from May 24 to end of June) on the undersides of beech logs. *Euchætes echidna* lives on the trunks of standing dead beech, as does also *Pleocamus hispidulus*. Of this latter species I took over 100 from the north side of a single dead beech tree. *Piezocorynus dispar* and *mixtus* were found on patches of a powdery fungus growing on *standing* dead beech. If they were not stealthily approached they would let go and drop partly to the ground and then fly. The "Clover root beetle," *Phytonomus punctatus*, is a recent introduction. I took a number from the stomach of a "Night Hawk" (*Chordeiles virginianus*). Of the *Anthribidæ* I have identified seventeen species.

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*Trans. Am. Ent. Soc. XV, April, 1888, p. 42.

†See paper this Journal, January, 1893.

ZOOLOGICAL MISCELLANY.

A BUTTERFLY NEW TO OHIO.—March 19, 1898, my son, Cuvier Dury, captured a male of the "Goat weed butterfly" (*Paphia troglodyta*) that was flying feebly along. This is the first instance of its capture in Ohio so far as noted. The day was warm and the sun shining, though this date is very early for butterflies to be on the wing. This species is abundant in some parts of Illinois.—*Charles Dury, Avondale.*

CALLIDRYAS EUBULE L.—This butterfly has always been exceedingly rare in this vicinity. September 16, 1897, late in the afternoon, I saw a male of the species hovering around the top of a soft maple sapling, among the foliage of which were a number of yellow leaves. It flew to the adjoining trees several times (their leaves were all dark green), but always came back to this tree (it being the only one with yellow leaves) in which it finally settled. It being such a rare insect in the locality (the third I have seen in twenty-five years), I went after a net to try and effect its capture. When I came back, even with the aid of two others, we were unable to see it, so perfectly did it mimic its surroundings, although the top of the sapling was only a few feet above our heads and the foliage three feet in diameter. After a fruitless search, we supposed it had gone and gave the tree a jar, when the butterfly dashed out and escaped. From its actions I believe it selected this tree from all the others, because its colors mimiced the yellow leaves on the tree.—*Charles Dury.*

"TOMATO WORM" PARASITE (*Apanteles congregatus* Say).—August 10, 1897, a "Tomato worm" (larva of *Sphinx celsus* Hübner) was brought to me, on the body of which were 240 (by count) of the little white cocoons (often erroneously called eggs) of this little fly. Is not this an extreme number of this common parasite on a single larva?—*Charles Dury.*

Botys penitalis Grote.— The magnificent group of "Lotus" (*Nelumbo nelumbo*) at Spring Grove cemetery was completely riddled and destroyed by this moth during the summer of 1897. I reared quantities of them from larvæ found in the stems of these plants. None of these larvæ seemed to be parasitized. This year the *nelumbo* has not come up at all, being entirely killed.— *Charles Dury.*

"Squirrel Bot Fly" (*Cuterebra emasculator*).— There is a legend, firmly believed by the old squirrel hunters of the Miami valleys, that the old male squirrels attack the young males and castrate them with their teeth. This legend was doubtless inspired by the fact that occasionally a male squirrel was found in which the testes were absent. This is the work of this "Bot fly," which deposits its eggs at the back of the scrotum of the squirrel. The egg hatches into a maggot that eats its way into the testes, and causes the destruction of one or both of these organs.—*Charles Dury.*

Parasites on the Common Rabbit (*Lepus sylvaticus* Bach.).—While hunting in Bracken County, Kentucky, during November and December, 1897, an examination was made of many of this species that were killed, and it was found that about fifty per cent were affected with internal parasites of several species, the most common being tape worms (*Citto-taenia*) of two forms. There were also smaller thread-like worms (*Sarcocystis*) and cyst-like bodies (probably hydatid cysts). The rabbits were fat, in fine condition, and apparently healthy. Some had been victims of the Rabbit Bot Fly (*Cuterebra*) earlier in the summer, but the fly had gone, and the animal had recovered from these attacks, as nothing remained but the cicatrix. I do not know of any animal that is so fearfully persecuted by parasites as these rabbits. The statement often heard that rabbits are not fit for food until after frost, is, no doubt, due to the frequency of the presence of the Bot fly larvæ and other parasites. While these Bot fly larvæ become full fed, and go through their transformations before frost, the statement is partly correct, but, in regard to the internal worms, it is not so, as they are present throughout the year.— *Charles Dury.*

SCREECH OWL (*Megascops asio* Linné).— April 14, 1895, Ralph Kellogg found eggs of this species in a cavity in a large beech tree, about thirty feet from the ground. There was no nest of any kind, but the eggs were deposited on a shelf of the wood projecting into the cavity, which was large. There were five white eggs, perfectly fresh when found. April 28 he climbed to nest again; none of the eggs yet hatched. Partly eaten body of hermit trush in the nest. May 12 we went to nest and found four eggs hatched. The young were strange looking objects, covered with white down, their eyes not yet opened. We took three of the young for preservation. May 16 I climbed to nest and took remaining bird (and one egg, which was addled): Pin feathers had sprouted a little, but birds had not increased much in size. When the first ones were taken, May 12, the down was perfectly dry and fluffy. They had then been hatched thirty-six or forty-eight hours, making the period of incubation about twenty six days. On the last visit to the nest there were two European sparrows (*Passer domesticus*), evidently killed the night before, and each with the entire head eaten off. At all times the place was perfectly clean and free from odor. The birds have been preserved in Mr. Kellogg's and my own collections, and one in the collection of Cuvier Club (No. 1346), May 4, 1898. Mr. F. B. Magill found a nest of *M. asio* in a hole in a locust tree; it contained three young, freshly hatched. His attention was attracted to the hole by seeing the body of a robin which the owl was trying to pull into the hole, the robin's tail and posterior part projecting.— *Charles Dury.*

FOOD OF RAPTORIAL BIRDS.— The following notes have accumulated in my note book since the publication of articles on the subject in this JOURNAL, April, 1885, and July, 1887.

Red-shouldered Hawk (*Buteo lineatus* (Gmelin)).—January 6, 1891; stomach contained skulls and other debris of several mice. November 6, 1891; stomach contained four garter snakes (*Eutænia sp.*), two of which, small ones, were swallowed entire. January 17, 1894; a male killed in Hamilton County, Ohio, contained a teacup full (by measure) of the common angle or earthworms. November 14, 1894; stomach con-

tained grasshoppers (*Caloptenus femur-rubrum*) in large quantity. November 29, 1894; bird killed at Indian Hill, Hamilton County, Ohio, stomach contained grasshoppers. October, 1895, bird killed at Pleasant Ridge, Hamilton County, Ohio, contained remains of several mice and grasshoppers.

Red-tailed Hawk (*Buteo borealis* (Gmelin)).—November 23, 1890; stomach contained one meadow shrew (*Blarina brevicauda*) swallowed entire. November 24, 1894; bird killed by myself at Foster's, Ky., contained one meadow shrew and two grasshoppers. January 20, 1895; bird killed at Wapakonetta, Ohio, contained oats—supposed to be the undigested remains of some granivorous bird.

Pigeon Hawk (*Falco columbarius* Linné).—April 14, 1895, female bird killed at the Marine Hospital, Cincinnati, contained European sparrow (*Passer domesticus* Linné. Skin of the hawk is in my collection.

Sparrow Hawk (*Falco sparverius* Linné), killed November 30, 1890, in this city, had his stomach filled with mice.

Barn Owl (*Strix pratincola* Bonaparte), killed November 18, 1890, at Nicholasville, Ky., contained remains of four mice. Bird killed April 28, 1894, at Reading, Hamilton County, Ohio, contained three full-grown shrews.

Barred Owl (*Syrnium nebulosum* (Forster)).—November 21, 1890; bird from Indian Hill contained remains of bob white (*Colinus virginianus* Linné). November, 1894; a female from Hamilton County, Ohio, contained the hair of several mice.

Short-eared Owl (*Asio accipitrinus* Pallas).—December 2, 1890; two specimens were filled with bird feathers and mouse hair. December 3, 1895; bird from Hamilton County, Ohio, contained mice—two whole ones and part of a third.

Screech Owl (*Megascops asio* (Linné)).—A female killed at Avondale, October 13, 1890, was filled with insects. Another female, killed the following day, was filled with grasshoppers. October 19; stomach contained European sparrow (*Passer domesticus*).

Great Horned Owl (*Bubo virginianus* (Gmelin)).—December 7, 1890, a pair, male and female, had been devouring a rabbit (*Lepus sylvaticus* Bachman).—*Charles Dury.*

A Vermilion-Albino Milk Snake.—A singularly-colored specimen of the common milk snake (*Ophibolus doliatus triangulus* Cope) was presented to the museum, May 18, last, by Mr. Charles Dury. It had been plowed up in a field near Covington, Ky. Our usual form of this species is grayish or yellowish white, with chestnut blotches, bordered with jet black. The specimen here referred to has nothing unusual in the pattern of its markings, but the color is quite peculiar. The white is of the purest chalk-white, the chestnut is replaced by a brilliant vermilion, and the borders of the blotches, instead of being black, are completely destitute of pigment. Iris vermilion; the pupil was ruby-red in the living specimen; now the alcohol has made the lens opaque, hiding the retina. The gastrosteges, usually checkered with whitish and black, are, in this specimen, pigmentless, except a few small squared spots, which are chalk-white. While alive, the animal was translucent, showing plainly the liver and opaque mass of contents in the stomach. Scales in 21 rows; gastrosteges 211; "saddles" 50, No. 39 over the vent; total length, $10\frac{3}{8}$ inches; tail, $1\frac{1}{2}$ inches; thus the tail a trifle more than one-seventh of the length. [Mus. Acc. Catalogue, No. 12,063.]—*Josua Lindahl.*

A Green Dog.—Mr. O. A. Stuckenberg, of Cincinnati, donated to the museum the fresh body of a grayhound pup which had died thirty six hours after birth, February 23, 1897. The color of its coat was distinctly asparagus green, except the head, of the ordinary gray color. Immersion in strong alcohol during several hours, proved as inefficient to change the color as the previous washing with soap-suds, and Mr. Stuckenberg's assurance that the pup was born with the green color can not be doubted. The skin was preserved, and still retains its colors. [Mus. Acc. Catalogue, No. 11,803.] —*Josua Lindahl.*

ARTICLE XVI.—THE MYXOMYCETES OF THE MIAMI VALLEY, OHIO.

By A. P. Morgan.

Fifth Paper.

(Read November 7, 1899.)

Systems of Classification of the Myxomycetes.

The milky or bright-colored strands and soft masses of the plasmodium must indeed have arrested the attention of the earliest observers, but it is plain that not much could be known of the Myxomycetes until the microscope had attained to considerable perfection. The study of them kept pace with that of the smaller fungi, and by the Linnæan writers they were fancifully distributed among the genera of these in accordance with their superficial appearance.

The earliest notice of any form of Myxomycetes is commonly assigned to Ray (1696), but Haller, in the Historia, attributes the origin of the terms Mucilago and Lycogala to Bonanni (1684). The two species mentioned by Ray (1696) were the *Arcyria punicea* and *Lycogala miniata* of Persoon. Ruppius (1718) described quite elaborately the *Stemonitis fusca* of Fries. In 1727, Marchand, of the French Academy of Sciences, brought to the notice of that body a "fungus production" which grew on tan, and which he called "fleur de tan;" he placed it under the phrase "Spongia fugax, mollis, flava, et amoena," as quoted by Haller and Linnæus. Micheli (1729) had a true conception of the myxomycetes; he observed their early mucilaginous state, and the intermingled spores and filaments of their mature condition. He figured and described the species known to him, and nearly all are distinguishable at the present time. Although classing them with Mucor and Lycoperdon, they were kept distinct in separate genera. We present, as follows, Micheli's account of the Myxomycetes observed by him:

CLATHROIDES.

Clathroides is a kind of plant which, before it emerges from the volva, is round, or turbinate, but as soon as it projects from it becomes elliptic. It is not hollow as in Clathrus, but in marvelous ways interwoven throughout most cunningly into the form of a net, within the meshes of which are contained the heaps of round and dry seeds.

The species of Clathroides are:

1. Clathroides purple, furnished with a pedicel.
2. Clathroides purple, without a pedicel.
3. Clathroides yellowish, without a pedicel.

CLATHROIDASTRUM.

Clathroidastrum is a kind of plant, different from Clathroides, not only the volva, out of which it arises, being seen with difficulty and being extremely fugacious, but also because it is furnished with a little stalk, which extends through the middle from base to apex.

The species of Clathroidastrum are—

1. Clathroidastrum dark colored, of larger size.
2. Clathroidastrum dark colored, of smaller size.

LYCOGALA.

Lycogala is a kind of plant, either round or roundish or reniform; it is furnished with a single cortex and the inner portion is reticulate; also it is filled with a rather thick fluid, which, the plant being injured, flows away in drops; in these drops are contained the round and very minute seeds. If, however, the plant and the rich included fluid be allowed to dry, the seeds are better observed.

The species of Lycogala are—

1. Lycogala gray and of larger size.
2. Lycogala globose, the size of a pea, and the color of melted bronze.
3. Lycogala globose, red, the size and shape of a grain of millet.

4. Lycogala yellow, the smallest of all, reniform.

5. Lycogala terrestrial, cæspitose, the color of melted bronze.

MUCILAGO.

Mucilago is a kind of plant, which in its early stage greatly resembles mucus or mucilage. It is protected by a single cortex, which, after drying up, is by degrees wholly resolved into a furfuraceous mass. In the first species, the substance being intersected by very thin membranes, it is plainly subdivided into cells, while such is not the case in the remaining species; but in all the species the substance is composed of very minute seeds and of fine threads connected together, and fastened as it were to a placenta.

The species of Mucilago are—

1. Mucilago of summer time, rufescent, hemispheric, growing upon the trunks of trees.
2. Mucilago crustaceous and white.
3. Mucilago, white, branched, simulating the fibrous roots of trees.
4. Mucilago very small, club-shaped, white as milk, furnished with a pedicel.
5. Mucilago very small, with the shape of a little Agaric, at first rufous, afterward cinereous.
6. Mucilago very small, not crustaceous, white, of the size and form of a grain of millet.
7. Mucilago very small, crustaceous, white, the capsules resembling a grain of millet, densely placed.
8. Mucilago white, crustaceous, the capsules distant from each other.
9. Mucilago crustaceous, lead-colored, very neat, the capsules small and close together.

Linnæus, in the Systema Naturæ (1735), established ten genera of the Fungi. In three of these, Clathrus, Lycoperdon and Mucor, from time to time, he placed a few species of Myxomycetes. Only two of these were originally described by himself.

In the first edition of the Species Plantarum (1753), Linnæus enumerated four species of Myxomycetes, as follows—

1. CLATHRUS DENUDATUS = 1. Clathroides of Micheli.

2. CLATHRUS NUDUS = Clathroidastrum of Micheli.

3. LYCOPERDON EPIDENDRUM = Lycoperdon epidendron, miniatum pulverem fundens. Buxbaum, En. Pl. Hal., 1721.

4. MUCOR EMBOLUS = 2. Embolus of Haller, 1742.

In the second edition of the Flora Suecica (1755) he enumerated —

5. CLATHRUS RECUTITUS.

6. MUCOR SEPTICUS = Spongia fugax, etc., of Marchand.

In the second edition of the Species Plantarum (1763)—

7. LYCOPERDON RADIATUM.

Several species of Myxomycetes were described by Haller in the Enumeratio (1742), and in the Historia (1768), but as he did not accept the binomial nomenclature of Linnæus, these species appear with the names of later authors appended. Haller created the genera Embolus, Sphaerocephalus (1742) and Fuligo, Trichia (1768).

John Hill, in "A History of Plants" (1751), proposed the name Arcyria for the Clathroides and Clathroidastrum of Micheli and the name Physarum to include Mucor, Lycogala and Mucilago of the same author. Gleditsch (1753) substituted Stemonitis for the Clathroidastrum of Micheli.

The additional species of the Myxomycetes contributed by the writers succeeding Linnæus down to the time of Persoon may be enumerated as follows —

Retzius, Act. Holm, 1769.

8—9. CLATHRUS RAMOSUS. *a. aureus. b. rufus.*

10. LYCOPERDON AGGREGATUM = 3. Clathroides flavescens, etc. Haller, En. Stirp, 1742.

11. LYCOPERDON STIPITATUM.

Scopoli. Flor. Carn, 1772.

12. ELVELA INFUNDIBULIFORMIS = Fungoides minimum infundibuli forma, etc. Micheli. N. P. G., 1729.

13. MUCOR SERPULA.

Scopoli. Ann. Hist. Nat., 177-.

14. MUCOR LYCOPERDOIDES.

Schaeffer. Index, 1774.

15. MUCOR OVATUS=Fuligo ovata, etc. Haller. Hist. St., 1768.
16. MUCOR CARNEUS=1. Mucilago of Micheli.
17. MUCOR GRANULATUS.

Leers. Flora Herb., 1775.

18. PEZIZA MINUTA.
19. MUCOR RUFUS=5 Sphaerocephalus rufus. Haller. En. Stirp., 1742.
20. MUCOR VIOLACEUS.
21. MUCOR LACTEUS=4. Mucilago of Micheli.
22. MUCOR COCCINEUS.
23. MUCOR PYRIFORMIS=1. Clathroides pyriforme, etc. Haller. En. Stirp., 1742.
24. MUCOR POMIFORMIS.

Muller. Flora Danica. 1777.

25. TUBULIFERA CERATUM.

Jacquin. Misc. Aust., 1778.

26. TUBULIFERA ARACHNOIDEA.

Hudson. Flora Anglica, 1778.

27. CLATHRUS CINEREUS=2. Sphaerocephalus niger, etc. Haller. En. Stirp., 1742.
28. LYCOPERDON FUSCUM=1. Lycogala, Micheli.

Retzius. Obs. Bot., 1779.

29. LYCOPERDON GREGARIUM.

Wiggers. Prim. Fl. Hols., 1780.

30. STEMONITIS TYPHINA.
31. EMBOLUS BICOLOR=Embolus seta nigra, etc. Linnæus. Fl. Suec., 1745.
32. MUCILAGO CRUSTACEA.=2. Mucilago of Micheli.

Batsch, Elenchus Fung., 1783.

33. LYCOPERDON CORTICALE.
34. LYCOPERDON CINEREUM.
35. LYCOPERDON COMPLANATUM.

Dickson. Fasc., Pl., 1785.

36. LYCOPERDON FRAGILE.

Batsch. El. Fung. cont. I, 1786.

37. LYCOPERDON FAVOGINEUM.

38. EMBOLUS PERTUSUS.

Batsch. El. Fung. cont. II, 1789.

39. MUCOR CANCELLATUS.

Bolton. Fungi Hal., 1789.

40. MUCOR LYCOGALUS.

Baumgarten. Flora Lips., 1790.

41. FULIGO PANICEA=8. Mucilago of Micheli.

Bulliard, Histoire des Champignons de la France, 1791, enumerated 37 species belonging to the Myxomycetes; he placed them in the genera Reticularia, Trichia, Sphaerocarpus, and Lycoperdon, inventing the first and third names for this purpose. Trichia contained 6 species belonging to Arcyria and Stemonitis, Sphaerocarpus contained 19 species of various genera of simple Myxomycetes, Reticularia included the Lycogala, Fuligo, and Spumaria of Persoon, except that *Lycogala miniata* was retained in Lycoperdon.

Bulliard's contribution to the number of species may be estimated as follows:

42. RETICULARIA SINUOSA.

43. TRICHIA AXIFERA.

44. TRICHIA LEUCOPODIA.

45. SPHAEROCARPUS UTRICULARIS.

46. SPHAEROCARPUS CHRYSOSPERMUS.

47. SPHAEROCARPUS AURANTIUS.

48. SPHAEROCARPUS GLOBULIFER.

49. SPHAEROCARPUS ALBUS.

50. SPHAEROCARPUS CAPSULIFER.

Schrader, in the Nova Genera Plantarum (1797), put forth the claim that the Myxomycetes deserve to constitute a proper natural family very different from the rest of the fungi. This family, to which he does not appear to have given a name, embraces two subdivisions: (1) The seminal powder, intermingled with a capillitium; and (2) the seminal powder naked or destitute of a capillitium. To the former pertain Didymium, Trichia, Arcyria, Stemonitis, Phy-

sarum, Fuligo, and Spumaria; to the latter, Cribraria, Dictydium, and Licea. The first subdivision, should it be necessary, can be separated again into several sections by the diversity of the capillitium.

In this essay Schrader proposes four new genera of the Myxomycetes — Cribraria, Dictydium, Licea, and Didymium. Each genus is carefully defined, and the species belonging to it known to him described and illustrated.

The Synopsis Methodica Fungorum of Persoon appeared in 1801. It was the next most important treatise upon the Fungi after that of Micheli. In this work the Fungi are divided into two classes, six orders, and seventy-one genera. The Myxomycetes are contained in eleven genera of third order Dermatocarpi. Nine of the genera belong to the first section Trichospermi, which includes, also, the puff-balls, and two of the genera are included in the second section Gymnospermi, which contains, also, Mucor, Puccinia, etc. Persoon described 79 species, and their distribution in the 11 genera may be shown, as follows:

ORDER III. DERMATOCARPI.

§1. TRICHOSPERMI.

Genus 19. Lycogala.

1. L. argentea; 2. L. turbinata; 3. L. punctata; 4. L. miniata; 5. L. conica.

Genus 20. Fuligo.

1. F. rufa; 2. F. violacea; 3. F. laevis; 4. F. flava; 5. F. vaporaria; 6. F. candida.

Genus 21. Spumaria.

1. S. mucilago; 2. S. physaroides.

Genus 22. Diderma.

1. D. floriforme; 2. D. stellare; 3. D. umbilicatum; 4. D. vernicosum; 5. D. (?) ramosum; 6. D. ochraceum; 7. D. contortum; 8. D. testaceum; 9. D. globosum; 10. D. difforme; 11. D. complanatum.

GENUS 23. PHYSARUM.

1. P. contextum; 2. P. confluens; 3. P. bivalve; 4. P. cinereum; 5 P. hyalinum; 6. P. muscicola; 7. P. nutans; 8. P. luteum; 9. P. viride; 10. P. aureum; 11. P. aurantium; 12. P. columbinum; 13. P. squamulosum; 14. P. tigrinum; 15. P. farinaceum; 16. P. (?) globuliferum.

GENUS 24. TRICHIA.

1. T. botrytis; 2. T. rubiformis; 3. T. fallax; 4. T. clavata; 5. T. nigripes; 6. T. ovata; 7. T. olivacea; 8. T. nitens; 9. T. varia; 10. T. serpula; 11. T. reticulata.

GENUS 25. ARCYRIA.

1. A. (?) leucocephala; 2. A. flava; 3. A. cinerea; 4. A. incarnata; 5. A. punicea.

GENUS 26. STEMONITIS.

1. S. leucostyla; 2. S. typhina; 3. S. fasciculata; 4. S. papillata; 5. S. ovata.

GENUS 27. CRIBRARIA.

1. C. cernua; 2. C. coccinea; 3. C. microcarpa; 4. C. splendens; 5. C. venosa; 6. C. macrocarpa; 7. C. rufescens; 8. C. argillacea; 9. C. vulgaris; 10. C. tenella; 11. C. intricata.

§2. GYMNOSPERMI.

GENUS 28. LICEA.

1. L. bicolor; 2. L. circumscissa; 3. L. pusilla; 4. L. variabilis; 5. L. flexuosa.

GENUS 29. TUBULINA.

1. T. fallax; 2. T. fragiformis.

The Synopsis of Persoon greatly facilitated the labors of students, and, no doubt, was a great stimulus to the study of the Fungi in all parts of Europe. Numerous publications appeared in the interval between it and the next great work upon the Fungi by Elias Fries.

Nees ab Esenbeck, in his elaborate "Das System der Pilze und Schwämme" (1817), placed the Myxomycetes in the third

kingdom (Gasteromyci) of his Vegetabilia mycetoidea (Pilze). They constitute the "Circulus primus" under the name, Aërogasteres; they are sharply distinguished from the "Circulus secundus," the Geogastri. Nees appears to be the first writer to separate the Myxomycetes from the Puff-balls. This same system appears in Martius's Flora Erlangensis.

The third important work upon the Fungi is the Systema Mycologicum of Elias Fries, in three volumes, 1821–1832. In this work the Myxomycetes appear in the second class, Gasteromycetes, under the title Myxogastres; they constitute the second sub-order of the third order, the Trichospermi. Fries made himself familiar with the works of all his predecessors, and with great care and nice judgment strove to arrange the synonymy. He studied diligently the "morphosis" of the primary mucilaginous stage in the different genera of the Myxogastres; he referred all the different forms to four types, and sought to make use of these in classification. Fries made but two additions to the genera of his predecessors, but he redefined and more strictly limited all of them.

The following is an outline of the sections and genera of Fries's system:

SUB-ORDER II. MYXOGASTRES.

§1. AETHALINI.

Genus 14. Lycogala; 15. Reticularia; 16. Aethalium; 17. Spumaria.

§2. PHYSAREI.

Genus 18. Diderma; 19. Didymium; 20. Physarum; 21. Craterium.

§3. STEMONITEI.

Genus 22. Diachea; 23. Stemonitis; 24. Dictydium; 25. Cribraria.

§4. TRICHIACEI.

Genus 26. Arcyria; 27. Trichia; 28. Perichaena; 29. Licea.

Under this system Fries described 192 species of the Myxogastres. It remained the working system for more than fifty years, and at the present time the specific forms recognized by Fries are scarcely to be questioned.

Wallroth in the Flora Germanica (1833) invented the name Myxomycetes, substituting it for the Trichospermi of Persoon and Fries; he described the Myxogastres of Fries under the Sections Placogasteres and Angiogasteres. Link, in the Handbook (1833), restricted the term Myxomycetes to nearly the limits of the Myxogastres of Fries.

Next, Dr. A. De Bary made an elaborate study of the structure and mode of life of the Myxomycetes. He published this in 1859, under the title "Die Mycetozoen," a second edition appearing in 1864. De Bary united the Myxomycetes with a few organisms called Acrasieae under the general title of Mycetozoa. He states, "I have since the year 1858, placed the Myxomycetes under the name of Mycetozoa, outside the limits of the vegetable kingdom."

Rostafinski, a student of De Bary's at Halle, and again at Strassburg, undertook to recast the system of The Myxomycetes in accordance with the views of his master. An outline of the system appeared in 1873 in his Inaugural Dissertation. The fully elaborated system was published in 1875, in a splendidly illustrated monograph, designed to include all the species of Myxomycetes known up to that date.

The following synopsis of the orders, families and genera of the Mycetozoa is made in accordance with the views expressed by Rostafinski, in the supplement to his monograph (1878).

MYCETOZOA.

I. AMAUROSPORAE.

Spores violet, or brownish violet.

§ 1. ATRICHAE.

Sporangia without a capillitium.

ORDER I. PROTODERMEAE.

FAMILY 1. PROTODERMACEÆ.

Genus 1, Protoderma.

§ 2. TRICHOPHORAE.

Sporangia always furnished with a capillitium.

ORDER II. CALCAREAE.

FAMILY 2. CIENKOWSKIACEAE.

Genus 2, Cienkowskia.

FAMILY 3. PHYSARACEAE.

Genus 3, Badhamia; 4, Physarum; 5, Fuligo; 6, Craterium; 7, Leocarpus; 8, Crateriachea; 9, Tilmadoche.

FAMILY 4. DIDYMIACEAE.

Genus 10, Chondrioderma; 11, Didymium; 12, Lepidoderma.

FAMILY 5. SPUMARIACEAE.

Genus 13, Diachea; 14, Spumaria.

ORDER III. AMAUROCHAETEAE.

FAMILY 6. ECHINOSTELIACEAE.

Genus 15, Echinostelium.

FAMILY 7. STEMONITACEAE.

Genus 16, Lamproderma; 17, Comatricha; 18, Stemonitis.

FAMILY 8. AMAUROCHAETACEAE.

Genus 19, Amaurochaete.

FAMILY 9. BREFELDIACEAE.

Genus 20, Brefeldia.

FAMILY 10. ENERTHENEMACEAE.

Genus 21, Enerthenema.

II. LAMPROSPORAE.

Spores variously colored, but never violet.

§ 1. ATRICHAE.

Sporangia without a capillitium.

ORDER IV. ANEMEAE.

FAMILY 11. DICTYOSTELIACEAE.

Genus 22, Dictyostelium.

FAMILY 12. LICEACEAE.

Genus 23, Licea; 24, Tubulina; 25, Lindbladia.

FAMILY 13. CLATHROPTYCHIACEAE.

Genus 26, Clathroptychium; 27, Enteridium.

ORDER V. HETERODERMEAE.

FAMILY 14. CRIBRARIACEAE.

Genus 28, Dictydium; 29, Heterodictyon; 30, Cribraria.

§ 2. TRICHOPHORAE.

Sporangia always furnished with a capillitium.

ORDER VI. COLUMELLIFERAE.

FAMILY 15. RETICULARIACEAE.

Genus 31, Siphoptychium; 32, Reticularia.

ORDER VII. CALONEMEAE.

FAMILY 16. PERICHAENACEAE.

Genus 33, Perichaena.

FAMILY 17, ARCYRIACEAE.

Genus 34, Cornuvia; 35, Arcyria; 36, Lachnobolus; 37, Dermodium; 38, Lycogala; 39, Oligonema.

FAMILY 18. TRICHIACEAE.

Genus 40, Prototrichia; 41, Trichia; 42, Hemiarcyria.

A monograph of the Myxogastres was published in 1892, by George Massee, of the Royal Herbarium, at Kew, England. It is elegantly illustrated by many plates with colored figures.

The orders and sub-orders of Massee's system are as follows:

ORDER I. PERITRICHEAE.

SUB-ORDER 1. TUBULINAE.

SUB-ORDER 2. CRIBRARIAE.

ORDER II. COLUMELLIFERAE.

SUB-ORDER 3. STEMONITAE.
SUB-ORDER 4. LAMPRODERMAE.

ORDER III. LITHODERMEAE.

SUB-ORDER 5. DIDYMEAE.
SUB-ORDER 6. PHYSARAE.

ORDER IV. CALOTRICHEAE.

SUB-ORDER 7. TRICHEAE.
SUB-ORDER 8. ARCYRIAE.

We present in the following pages a synopsis of the orders and genera of the Myxomycetes of North America so far as known, under four sections—Peritrichiae, Calonemata, Columelliferae and Calcareae. This is preceded by two analytic tables leading to the genera as numbered in the synopsis.

TABLE I.

SPORANGIA COMBINED INTO AN AETHALIUM.

a. Aethalium containing lime. (b.)
Aethalium containing no lime. (c.)
b. Lime in the form of minute roundish granules. 37.
Lime in the form of minute stellate crystals. 27.
c. Aethalium effused with a plane surface. (d.)
Aethalium pulvinate or subglobose. (e.)
d. Walls of the sporangia a thin persistent membrane. 2.
Walls of the sporangia with a persistent apex and six slender threads. 6.
e. Thin membranes and slender fibers intermingled with the spores. (f.)
Slender warted tubules intermingled with the spores. 9.
f. Fibers bearing small membranaceous vesicles. 5.
Fibers not bearing any vesicles. 4.

TABLE II.

SPORANGIA SIMPLE AND STIPITATE OR SESSILE.

a. Sporangia containing lime. (b.)
Sporangia containing no lime (g.)

b. Capillitium inclosing granules of lime. (c.)
Capillitium containing no lime. (f.)

c. Granules of lime aggregated into nodules. (d.)
Granules of lime lining or filling the tubules. 38, 39.

d. Surface of the sporangium invested with granules of lime. (e.)
Surface of the sporangium destitute of lime. 30, 31, 32.

e. Stipe prolonged within the sporangium as a columella. 33, 34.
Stipe never entering the sporangium. 35, 36.

f. Lime on the wall of the sporangium in the form of minute stellate crystals. 26.
Lime on the wall of the sporangium consisting of minute roundish granules. 28, 29.

g. Stipe prolonged within the sporangium as a columella. (h.)
Stipe never entering the sporangium. (l.)

h. Stipe and columella, brown or black. (i.)
Stipe and columella, white or yellowish. 25.

i. The columella scarcely reaching the center of the sporangium. 20, 21.
The columella extending beyond the center of the sporangium. (k.)

k. Threads of the capillitium radiating from numerous points of the columella. 22, 23.
Threads of the capillitium pendant from a discoid membrane at the apex of the columella. 24.

l. Capillitium traversing the interior of the sporangium and intermingled with the spores. (m.)
Capillitium rudimentary or connate with the wall of the sporangium. (r.)

m. Tubules of the capillitium furnished with spiral ridges. (n.)
Tubules of the capillitium not marked with spiral ridges. (o.)

n. Capillitium of short free elaters. 18, 19.
Capillitium of long slender attached tubules. 16, 17.
o. Tubules of the capillitium forming a complicated network. (p.)
Tubules of the capillitium forming no evident network. (q.)
p. Capillitium proceeding from numerous points of the sporangial wall, 13.
Capillitium issuing from the interior of the stipe, 14, 15.
q. Wall of the sporangium with an outer layer of minute scales and granules, 11, 12.
Wall of the sporangium not thickened, 10.
r. Wall of the sporangium a thin membrane with distinct fibrous thickenings, which form a network, 7, 8.
Wall of the sporangium a thin membrane, often granulose-thickened (s).
s. Sporangia sessile, 1. 2.
Sporangia stipitate, 3.

MYXOMYCETES.

§1. PERITRICHIÆ.

Sporangium destitute of lime and the stipe never prolonged into a columella. Capillitium more or less rudimentary, connate with the inner surface of the wall of the sporangium.

I. LICEACEÆ. Wall of the sporangium a thin membrane, often granulose-thickened.

a. Sporangia sessile.

1. LICEA. Sporangia simple and regular or plasmodiocarp, gregarious; hypothallus none.

2. TUBULINA. Sporangia cylindric, distinct or more or less connate and æthalioid, seated upon a common hypothallus.

b. Sporangia stipitate.

3. ORCADELLA. Sporangium urn-shaped, opening by a deciduous lid.

II. RETICULARIACEÆ. Wall of the sporangium a thin membrane, with distinct fibrous thickenings; the membrane, or at least certain portions of it, disappearing at maturity.

a. Sporangia combined into an æthalium.

4. RETICULARIA. The persistent fibrous thickenings of the sporangial walls irregular and without any vesicles.

5. BREFELDIA. The persistent fibrous thickenings of the sporangial walls, bearing polycellular vesicles.

6. CLATHROPTYCHIUM. The persistent fibrous thickenings consisting of six simple threads extending from the angles of the hexagonal apex downward to the base of the sporangium.

b. Sporangia simple and stipitate.

7. CRIBRARIA. Capillitium of slender threads combined into a net-work of polygonal meshes.

8. DICTYDIUM. Capillitium of numerous convergent ribs which extend from base to apex and are united by fine transverse fibers, thus forming a net-work of rectangular meshes.

III. LYCOGALACEAE. Aethalium with a firm membranaceous wall, from the inner surface of which proceed numerous slender warted tubules (?).

9. LYCOGALA. Aethalia subglobose.

§ 2. CALONEMATA.

Sporangia containing no lime and without a columella; capillitium of bright-colored much elongated threads, which traverse the interior of the sporangium and are intermingled with the spores, usually kinked and coiled, and by reason of this exhibiting elasticity; the walls of the threads marked externally by characteristic thickenings.

IV. PERICHAENACEAE. Sporangia sessile; tubules of the capillitium proceeding from numerous points of the

sporangial wall, loosely branched and forming no evident net-work, the surface even, minutely warted or spinulose.

a. Wall of the sporangium not thickened.

10. DIANEMA. Capillitium of nearly straight smooth threads running from base to top of sporangium.

b. Wall of the sporangium with an outer layer of minute scales and granules.

11. PERICHAENA. Sporangia more or less depressed, roundish, or more commonly polygonal and irregular, dehiscent in a circumscissile manner.

12. OPHIOTHECA. Plasmodiocarp terete and more or less elongated, bent and flexuous, sometimes annular or reticulate, irregularly dehiscent.

V. ARCYRIACEAE, Sporangia stipitate, rarely sessile; capillitium of slender tubules repeatedly branching and anastomosing to form a complicated net-work of evident meshes.

a. Capillitium proceeding from numerous points of the sporangial wall.

13. LACHNOBOLUS. Tubules of the capillitium quite variable in thickness, the surface minutely warted or spinulose.

b. Capillitium issuing from the interior of the stipe.

14. ARCYRIA. Capillitium without any free extremities.

15. HETEROTRICHIA. Capillitium with numerous free extremities.

VI. TRICHIACEÆ. Capillitium of slender tubules, simple or branched; the surface furnished with continuous ridges, which wind around the tube in a spiral manner.

a. Capillitium of long, slender tubules, arising from the base of the sporangium or issuing from the interior of the stipe.

16. HEMIARCYRIA. Spiral ridges of the capillitium parallel and conspicuous.

17. CALONEMA. The surface of the tubules traversed by a system of branching veins.

b. Capillitium of short, slender tubules, called elaters, which are wholly free.

18. TRICHIA. Spiral ridges of the capillitium parallel and conspicuous.

19. OLIGONEMA. Capillitium scanty, composed of elaters, habitually irregular and abnormal.

§3. COLUMELLIFERÆ.

Sporangium containing no lime; stipe entering the sporangium and forming a more or less elongated central columella, which gives origin to a capillitum of rigid, persistent brown threads.

VII. STEMONITACEÆ. Sporangia, globose or ovoid to oblong and cylindrical, stipitate; the wall very thin and fragile, soon disappearing.

A. stipe and columella brown or black.

a. The columella scarcely reaching the center of the sporangium.

20. CLASTODERMA. Threads of the capillitium forking repeatedly, but not combined into a network.

21. LAMPRODERMA. Threads of the capillitium branching and anastomosing to form a network.

b. The columella extending beyond the center of the sporangium.

22. COMATRICHA. Threads of the capillitium forming only an interior network, attaining the wall by numerous more or less elongated free extremities.

23. STEMONITIS. Threads of the capillitium forming an interior network of large meshes and a superficial network of smaller meshes.

24. ENERTHENEMA. Threads of the capillitium pendent from a discoid membrane at the apex of the columella.

B. Stipe and columella white or yellowish.

25. DIACHEA. Threads of the capillitium branching and anastomosing to form a network.

§4. CALCAREÆ.

On or within the walls of the sporangia and often in the capillitium deposits of lime under the form of granules or crystals of carbonate of lime.

VIII. DIDYMIACEÆ. Wall of the sporangium a thin membrane with an outer layer of crystals or granules of lime; columella usually conspicuous; capillitium of slender sinuous threads, scarcely branched and containing no lime.

a. Lime on the wall of the sporangium in the form of minute stellate crystals.

26. DIDYMIUM. Sporangium simple, subglobose, and stipitate, the base commonly umbilicate, or sometimes sessile and plasmodiocarp.

27. SPUMARIA. Aethalium composed of numerous elongated irregularly-branched sporangia closely compacted together and confluent.

b. Lime on the wall of the sporangium consisting of minute roundish granules.

28. DIDERMA. Wall of the sporangium with the outer calcareous layer usually compacted into a smooth continuous crust.

29. LEPIDODERMA. Wall of the sporangium with an outer layer of large scales consisting of bicarbonate of lime.

IX. PHYSARACEAE. Wall of the sporangium a thin membrane, usually with an outer layer of minute roundish granules of lime; capillitium of slender tubules, which branch repeatedly and form an intricate network; the tubules expanded at the angles of the network and inclosing granules of lime.

I. Tubules of the capillitium having the granules of lime in them aggregated into roundish or angular nodules.

A. Outer surface of the sporangium destitute of lime.

30. ANGIORIDIUM. Plasmodiocarp laterally compressed, splitting regularly into two valves.

31. CIENKOWSKIA. Plasmodiocarp terete, elongated, irregularly dehiscent.

32. LEOCARPUS. Sporangia subglobose, or obovoid, stipitate or sessile.

B. Outer surface of the sporangium invested with granules of lime.

a. Stipe prolonged within the sporangium as a columella.

33. PHYSARELLA. Sporangium oblong, stipitate, the apex re-entrant.

34. CYTIDIUM. Sporangium globose, stipitate, apex convex.

b. Stipe never entering the sporangium.

35. CRATERIUM. Sporangia obovoid to cylindric, stipitate.

36. PHYSARUM. Sporangia globose, depressed globose or irregular, stipitate or sessile.

37. FULIGO. Aethalium a compound plasmodiocarp.

II. Tubules of the capillitium with the granules of lime in them distributed throughout their entire length.

38. BADHAMIA. Stipe not prolonged within the sporangium as a columella.

39. SCYPHIUM. Stipe entering the sporangium and prolonged within it as a columella.

ARTICLE XVII.—RANDOM NOTES ON NATURAL HISTORY.

By Charles Dury.

A. ODONATA.

At the request of the late Professor Kellicott, of Columbus, I have made a collection of these beautiful insects in the immediate vicinity of Cincinnati. I began in the summer of 1897, too late for the early species. Early in 1898 a few of the *Gomphinæ* were taken, but during the spring of 1899 conditions were so unfavorable that little could be done. This will account for the small number of species of this sub-family in the following list of Cincinnati dragon flies. The locality seems to be quite rich in species of *Odonata*, sixty-two having been identified to this date. Many of them have been observed in Spring Grove Cemetery, our beautiful, well-kept city of the dead, whose lakes of pure water are ideal breeding places for these insects. The lakes are stocked with bass and other fish, which devour immense quantities of both nymphs and imagos. As the dragon flies skim along above the surface of the water the large-mouthed bass follow them around trying to snap them up when they touch the water in ovipositing. The eggs of many species, when extruded, adhere to the tip of the abdomen. By the motion of the female, as she touches the water in flight, the eggs are washed off and settle to the bottom, where they hatch. I have seen the female snatched away from the male by a hungry bass, as they were flying in couple, at the instant she attempted to drop her eggs. The nymphs of the dragon flies are insatiable in their voracity. On August 22, 1898, I brought home a lot, and fed one of them a bit of earthworm, which it seized with its jaws crossways; it turned it with its forefeet and swallowed it entire. In two days the nymphs had eaten each other up until only the largest one remained.

Under favorable conditions these insects breed in vast

numbers. Along a small creek, June 25, 1899, I counted thirteen species of the *Agrioninæ*, and they were in such swarms that they presented a remarkable sight.

The following is a list of the species collected in this vicinity, with notes on some of them. My thanks are due Professor Hine, of Columbus, for assistance in their identification:

Calopteryx maculata Beauvois.
Hetærina americana Fabricius.
Hetærina tricolor Burmeister.
Lestes unguiculata Hagen.
Lestes disjuncta Selys.
Lestes rectangularis Say.
Lestes inæqualis Walsh.
Argia putrida Hagen.
Argia violacea Hagen.
Argia apicalis Say.
Argia sedula Hagen.
Nehalennia posita Hagen.
Amphiagrion saucium Burmeister.

Enallagma traviatum Selys. June 9th to July 8th, at lakes in Spring Grove, this species flies, by hundreds, a few inches above the water and generally in couple, stopping at intervals on a leaf of some pond plant to oviposit. On June 20, I saw a female submerged about four inches, clinging to the stem of a *Sagittaria*, ovipositing. They fly most abundantly in the morning; in the afternoon they take shelter in the bushes, and are much less active.

Enallagma civile Hagen. Very abundant, June to September. On July 29, 1897, I saw a pair of this species ovipositing on a submerged twig. The female was entirely under water, and the male, clasping her neck with the tip of his abdomen, was standing upright, with swiftly moving wings, trying to retain his hold and yet not be drawn under water.

Enallagma carunculatum Morse. Taken here, July 19, 1895, by Professor Kellicott. I have not seen it since.

Enallagma geminatum Kellicott.
Enallagma exsulans Hagen.

Enallagma antennatum Say.
Enallagma signatum Hagen.
Ischnura verticalis Say.
Anomalagrion hastatum Say.
Gomphus vastus Walsh.
Gomphus quadricolor Walsh.
Gomphus fraternus Say.
Gomphus villosipes Selys.
Anax junius Drury.

Anax longipes Hagen. June 2, 1898, one of this species was flying over Glen Lake in Spring Grove. I watched it for two hours, and though it came within a few feet of me, I was unable to catch it. It was a very large specimen, the abdomen bright brick red, thorax and eyes green. June 3, I went again to this lake, but did not see it until I moved down to Linden Lake, nearly adjoining, when I again saw it, but failed to catch it. Its flight is steady and in regular beats up and down the middle of the lake, seldom coming near shore. I made careful search during June, 1899, but did not see any at these lakes.

Basiæschna janata Say.
Epiæschna heros Fabricius.
Æschna constricta Say.
Æschna verticalis Hagen.
Æschna clepsydra Say.
Macromia illinoisensis Walsh.
Didymops transversa Say.

Neurocordulia obscura Say. Five specimens, viz., one male and four females, were taken in Eden Park, May and June, 1898 and 1899. This is new to the Ohio list, which now numbers 103 species.

Epicordulia princeps Hagen. June, July, and August. This species will dart at a clod thrown up to attract its attention. I have decoyed them within reach of the net in this way.

Tetragoneuria cynosura Say.

Pantala hymenæa Say. On July 22, 1899, several were

seen flying about some puddles near Little Miami River. They were ovipositing in these pools, which dried up entirely a few days later. Are all these eggs lost? Taken here by Professor Kellicott, July 18, 1895.

Tramea lacerata Hagen. Very abundant from May to October. The male of this species, when flying around in couple, holds the female with his claspers just back of the head, and seems to steer to a suitable place. They poise a few inches above the water, and, as the female dips downward with the tip of her abdomen into the water, the male releases his hold, eggs are deposited, the male then regains his hold, and they fly up and around again.

Tramea carolina Linné.

Tramea onusta Hagen. At Linden Lake they were numerous, but quite difficult to catch. Several pairs were observed, ovipositing, May 17 to June 30, 1898. On May 17, 1899, I went to Linden Lake to secure a few *onusta* where I had taken them the year before. I took four specimens of *carolina*, which were flying abundantly, but not one *onusta* was observed during 1899.

Libellula basalis Say. On July 14, one of this species was captured in the act of chewing up a *Hippodamia*.

Libellula auripennis Burmeister.

Libellula cyanea Fabricius. Three male specimens were taken at Spring Grove, June 6, 1899, flying low along the border of a shallow lake; no female was seen.

Libellula vibrans Fabricius. Specimens of this most beautiful species were flying, May 28, 1899, along a branch of Duck Creek; they were fresh and bright.

Libellula incesta Hagen.
Libellula semifasciata Burmeister.
Libellula pulchella Drury.
Plathemis trimaculata DeGeer.
Celethemis eponina Drury.

Celethemis elisa Hagen. May 23, 1898, at Linden Lake, this species was emerging in prodigious numbers, and by the 27th had scattered all over the cemetery, resting on grass, bushes, and trees.

Celethemis fasciata Kirby.
Leucorhinia intacta Hagen.
Diplax rubicundula Hagen.
Diplax assimilata Uhler.
Diplax obtrusa Hagen.
Diplax vicina Hagen.
Diplax semicincta Say.
Perithemis domitia Drury.
Mesothemis simplicicollis Say.
Pachydiplax longipennis Burmeister.

B. LEPIDOPTERA.

Thecla halesus Cramer. This large and beautiful thecla was taken by me at Cincinnati, September, 1885. A perfectly fresh specimen (female) was perched on the flower of a "golden rod." I have not seen it here since. I have found it abundant in Volusia County, Florida.

Two species of butterflies new to the State* have been taken at Cincinnati during 1899. They are:

Thecla irus Godart (taken by Mr. Thiel), and
Eudamus lycidas Smith and Abbott, July 23.

Lemonias duryi Edwards. In his excellent "Butterfly Book," p. 230, Dr. Holland says of this species: "The only specimen as yet known is the type" (fig. 10, Pl. XXVIII). Five specimens were taken by me at the time (April), and more seen. They were flying along near the ground. The locality was among the foothills of the Organ Mountains, about five miles east of Mesilla, N. M. Two of them were sent to Mr. Edwards. As compared with the three in my collection, which are quite uniform in color and marking, the figure above

*See Sixth Annual Report of the Ohio State Academy of Science, pp. 22–27, and Seventh Report, p. 55.

mentioned is hardly recognizable, mine being so much brighter, and they do not very closely resemble *Lemonias cythera*, being of a different color and having fewer white spots on the upper surface.

C. DIPTERA.

Mallophora orcina Weid. In a field near Hyde Park this powerful "robber fly" was very abundant from June to October, 1899. Its favorite victims were hymenopterous insects, mostly honey bees. I have several specimens taken in the act of killing bumblebees, larger than themselves; seventy specimens collected.

D. COLEOPTERA.

Leptura emarginata Fabricius. On July 2, 1899, I found a dead beech stub, about one foot in diameter and ten feet high, which was perforated with many round holes, from which these rare beetles had emerged. One of them was taken in the act of crawling out. I had only seen a single specimen before in many years' collecting.

Sandalus niger Knoch. This beetle has always been rare here. Five or six specimens only had been taken in many years. Five years ago, Mr. Thiel observed many of them crawling up and down the trunks of some ash trees (*Fraxinus americana*) in one of the parks. Each year he visited the place at the same date (in September), but never saw any more until September, 1899, when they were again abundant. September 27, 1899, I removed the sod under these trees and found many circular holes from which *Sandalus* had emerged. The holes were perfectly round; those for the females were of larger size. I took a mature male and female each from a burrow as they were in the act of emerging. I found no larvæ. All had seemingly pupated quite deeply in the ground. When they hatch they dig to the surface of the ground and emerge. Many of the larger branches of the trees are dead, caused, perhaps, by the work of this beetle on their rootlets.

October 22, 1899, a female was observed ovipositing in a crevice in the bark of an ash tree near my house. October 13, 1899, *Sandalus* were abundant on ash trees. A fresh female examined was found to contain an immense number of very small oblong white, translucent eggs. Several spent females, that were picked up from the ground in a dying condition, had but few eggs left in them. The females do not fly much, but run up and down the trunks of the trees. The males fly actively about and pair with the females. The female deposits her eggs in crevices. I see no evidence that the larvæ feed on any part of the tree except the roots. They seem to follow the roots out some distance from the trunk of the tree and pupate.

E. PISCES.

Lepidosteus osseus (Linné). A female of the long-nosed gar, from Lake Erie, of six pounds weight, contained an egg mass which weighed fourteen ounces, and, by count, numbered 34,160 eggs.

F. AVES.

Urinator lumme (Gunnerus). Mr. J. H. Meier, on January 11, 1895, shot a red-throated loon (male) near the Little Miami River. His attention was attracted to the bird by hearing it scream. Its note, he says, "was like the voice of a woman in distress." The specimen is in the Cuvier Club museum.

Anhinga anhinga (Linné). Two females of the *anhinga*, confined in the Zoological Garden in an aviary together with woodducks, were very vicious, picking out the ducks' eyes with their sharp beaks.

Phœnicopterus ruber (Linné). A flamingo at the Zoological Garden refused to eat the food natural to such birds, but subsisted entirely on boiled rice.

Botaurus lentiginosus (Montag). On November 15, 1899, a male American bittern was received from Franklin, Ohio. Its stomach was found to contain one entire short-tailed shrew *Blarina brevicauda* (Say), and also the hair of another — a very unusual food for this species.

Grus americana (Linné). In August, 1895, Mr. F. B. Magill saw a whooping crane on the Little Miami River, near Indian Hill Station.

Actitis macularia (Linné). On June 25, 1899, near Turtle Creek, in Warren County, Ohio, Mr. R. Kellogg and myself observed a female of the spotted sandpiper, followed by two very small young ones, running through a sandy field. They ran at full speed, the female making a loud cry of alarm. Seeing that we were gaining on, and would capture, her young, she changed her note, and at that instant the young ones stopped, squatted flat down, shut their eyes, and remained motionless, becoming invisible to our eyes, so perfectly did their colors mimic the sand and pebbles. We would surely have lost them if we had not had our eyes on them at that instant.

Elanoides forficatus (Linné). An adult male of the swallow-tailed kite was shot at Chillicothe, Ohio, August, 1898. Its stomach contained twenty-eight grasshoppers, twenty-four of which were *Melanoplus differentialis*, a rather large and destructive species. All of these had the heads bitten cleanly off by the kite. The four small ones were swallowed entire. This most elegant hawk is very rare in Ohio.

Mimus polyglottus (Linné). Parker Donaldson reports the mocking bird as a resident of his farm, two miles above New Richmond, Clermont County, Ohio. They nest there, and they remained throughout the winter of 1898–99, which was the coldest ever known here. They were seen in February, 1899, after the cold weather had abated. I visited the place, June 3, 1899, but no birds were singing. I saw the nests that had been used. Mr. Donaldson mentions a curious habit the male bird has of flying up in the air, singing loudly all the time. It then comes tumbling head over heels to the ground; when it nearly reaches the earth it quickly rights itself and darts into a bush or hedge.

ARTICLE XVIII.—NOTES ON A COLLECTION OF PLEISTOCENE SHELLS FROM MILWAUKEE, WISCONSIN.

BY FRANK C. BAKER, Chicago.

Mr. A. W. Slocum has recently collected a few pleistocene mollusks near Milwaukee, Wis., and has placed them in my hands for determination. The collection seems of enough interest to warrant a few notes.

Part of the specimens were found in a marl bed and the rest in a clay and peat bed; four feet below the latter the bones of an elephant were found. Nine species were found in the marl bed, and three in the clay and peat beds. Mr. Slocum reports that he found the same fauna in two places, six or seven miles apart. The specimens are beautifully preserved, some individuals having a highly polished surface. Specimens were extremely numerous in the marl bed, but were not so numerous in the clay and peat beds. The following species were collected:

PELECYPODA.

1. SPHÆRIUM SIMILE Say. Peat and clay bed. Not common. The umbones are placed nearer to the anterior end than in the forms now found living in this region, and the beaks are not so prominent. Of six valves examined five were right and but one a left valve. The collection contained one young specimen, seven mm. long, and very heavily striated.

2. SPHÆRIUM RHOMBOIDEUM Say. Peat and clay bed. Typical and rare.

3. PISIDIUM COMPRESSUM Prince. Peat and clay bed. Typical and with well preserved epidermis. The valves are attached to each other, in most cases.

*A set of these fossils has been received from Professor Baker as a donation to the Cincinnati Society of Natural History. They are entered in the accession catalogue of the Museum under Nos. 12206 to 12217.—J. L.

GASTROPODA.

The gastropods were all found in a marl bed; the latter being very soft, the specimens were very easily worked out, and were perfectly preserved.

4. LIMNÆA PALUSTRIS, Müller.

5. LIMNÆA REFLEXA Say. Elongate variety. Typical but not common.

6. LIMNÆA DESIDIOSA Say. Rather common. The whorls are rather gibbous, and the aperture in some specimens is rather flaring. In several individuals the whorls are much swollen, the spire very short and the aperture of good length. The specimens range in size from five to ten millimeters in length.

7. PLANORBIS CAMPANULATUS Say. Common and typical. The recent *campanulatus* is frequently subject to considerable variation in the whorls, they being distorted by showing the whorls above or below the plane of the aperture. Among the fossil *campanulatus*, twenty in number, not a specimen was thus distorted. The bell-shaped aperture was more spreading than usual in some individuals.

8. PLANORBIS BICARINATUS Say. Common and typical. All of the specimens are rather small, not exceeding eleven millimeters in greatest diameter.

9. PLANORBIS DEFLECTUS Say. Common and typical.

10. PHYSA HETEROSTROPHA Say. Very common. Varies from the typical *heterostropha* to a form near *gyrina*. In some individuals the aperture is wide and flaring. The whorls number four and a half in all of the specimens. They do not differ in any particular from individuals of the recent *heterostropha*.

11. PHYSA ANCILLARIA Say. This is a form somewhat between *heterostropha* and *ancillaria*. It is obconic in form, the aperture somewhat spreading, and the whorls shouldered and four and one half in number.

12. CINCINNATIA CINCINNATIENSIS Anth. Very common. Some specimens approach *Amnicola limosa* in form, the spire

being somewhat depressed and the whorls swollen. All of the specimens are small, not exceeding four and one half mm. in length.

13. VALVATA SINCERA Say. Not common. The specimens before the writer show some variation, particularly in the height of the spire and the deflection of the aperture. The sutures are all deeply channeled.

14. VALVATA TRICARINATA Say. Very common and variable. The individuals may be ecarinate, bicarinate or tricarinate. A search for quadri-carinate specimens (as mentioned by Mr. Bryant Walker*) was not successful. The ratio of ecarinate specimens, about two in five, was greater than among recent *tricarinata*. Bicarinate forms were about one in five.

*The Nautilus, Vol. XI, p. 121, 1898.

NEW AMERICAN PALEOZOIC OSTRACODA.

BY E. O. ULRICH.

NO. 1. CTENOBOLBINA AND KIRKBYA.

Since the publication of my paper on "New and Little Known American Paleozoic Ostracoda," in Volume XIII of the Journal of the Cincinnati Society of Natural History (1890–91), much new material has been collected and picked over, in part or wholly. The earlier washings, of which samples merely had been searched in 1890, have now been almost entirely worked out. The result is an astounding number of new species, the number of the undescribed forms falling little short of two hundred!

Perhaps the most interesting of all the localities furnishing ostracoda is the Bryozoa bed, at the Falls of the Ohio, opposite the city of Louisville, Ky. In 1890, when my former paper describing species from this locality was written, the pickings from the small sample of washings then examined was believed to give a fair, if not a full, idea of the species occurring there. How far from the truth this conception was, and how other localities when carefully investigated may be expected to add, more or less largely, to the number of known species, is shown by the fact that, when the last of the washings from the Falls in my possession had been searched the number of species known from that locality was nearly doubled.

This continual accession to the number of known forms proves that we have not yet reached that point where an approximately stable classification of the paleozoic representatives of the class is possible. My aim, therefore, in this and succeeding papers, in which I hope to publish illustrations and brief descriptions of the new species and varieties, is principally to add to the facts and data pertaining to specific variation, and to leave the restriction and characterization of the genera and families to such a future time when the discovery of more or less disturbing new forms will have become comparatively rare.

CTENOBOLBINA SUBCRASSA, n. sp.

Plate VIII, Figs. 1-3.

Size: Length, 1.15 mm.; hight, 0.7 mm.; thickness, 0.6 mm.

Carapace widest in the posterior half, obliquely subovate, the hinge line long and straight. Flange thick and well developed along the posterior and ventral sides, weak or quite obsolete in front, partly overhanging the ventral contact edge of the valve and hiding a number of rather faintly marked transverse depressions between them. Anterior sulcus obsolete or distinguishable only in the dorsal region, the posterior one strongly impressed, especially upon the posterior side, extending obliquely backward and downward more than two-thirds across the valve. A small tubercle occurs in the antero-dorsal corner of the posterior lobe, while a thin and prominent ridge runs along the lower side of the combined median and anterior lobes. Between this ridge and the flange the surface is sharply excavated. Surface without ornament.

This species finds its nearest relations in *C. crassa* and *C. fulcrata*, occurring in the shales of the Black River group in Minnesota. A comparison with the published figures of these species will not only show this relationship, but at the same time reveal several obvious differences by which the species may be recognized.

Formation and Locality.—In a thin band of shale belonging to the Ridley limestone division of the Stones River group, near the bottom of the Kentucky gorge, at High Bridge, Ky.

CTENOBOLBINA OBLIQUA, n. sp.

Plate VIII, Fig. 4.

Size: Length, 1.1 mm.; hight, 0.7 mm. without flange, 0.75 mm. with flange.

This is a moderately convex and very simple species of the genus, there being a single sulcus, curved, but on the whole nearly vertical, and sharply defined on the posterior side only. The valves are shorter and more oblique than usual, and the flange a delicate projecting plate or fill; the surface is minutely reticulate or punctate. A small tubercle is situated near the middle of the antero-ventral fourth.

Only one other species of *Ctenobolbina* is known having a punctate surface; this is a Niagara species to which I gave the name *C. punctata*. The present form is relatively shorter, less convex, and strikingly different in the outline of the anterior half. The sulcus also is much less developed.

Formation and Locality.—Rare on thin slabs of limestone, from the lower portion of the Clitambonites bed of the Trenton group at Kenyon, Minn.

CTENOBOLBINA SPICULOSA, n. sp.

Plate VIII, Fig. 5.

Size: Length, 1.65 mm.; hight, with flange, 1.0 mm., without flange, 0.8 mm.

This fine species, although given a very different expression by its spinous surface, is nevertheless a close ally of *C. antespinosa*, Ulr., with which it is also associated at the Falls of the Ohio. Comparing the two species, we find that the central tubercles and ridges of *C. antespinosa* are all reproduced in *C. spiculosa*, but in a more subdued form. The vertical anterior ridge is represented by a couple of spines merely. The posterior lobe, on the other hand, is more prominent and drawn out above into a strong spine. All the surface elevations are granulose in *C. spiculosa*, and, excepting one, spiniferous as well. Two bunches of spines occur also near the post-ventral margin. The flange is wider in *C. spiculosa* and merely convex instead of bent angularly, and the valve, excluding the flange, more nearly equal-ended.

Formation and Locality.—From the Devonian (Hamilton group) bryozoa bed at the Falls of the Ohio.

CTENOBOLBINA ARMATA, n. sp.

Plate VIII, Fig. 6.

Size: Length, 1.38 mm.; hight, 0.78 mm.

This also is related to *C. antespinosa*, but is readily distinguished. The posterior sulcus passes completely through to the flange, which, on the contrary, is a comparatively insignificant feature. The lower portion of the posterior lobe is raised into a compressed spine, projecting outward and downward to the ventral margin. A similar but more prominent

and more curved spine is formed by the posterior extremity of the anterior lobe, which in this and other species of this section of the genus is longitudinal rather than vertical. Excepting the two ventral spines, the elevated portions of the surface are coarsely granulose. The middle lobe is rounded, situated about in the middle of the dorsal slope, and larger than the rounded upper portion of the posterior lobe.

The large, compressed spines, arising in the post-ventral fourth of the valves, will distinguish this species from any other previously described.

Formation and Locality.—Same as the preceding.

Ctenobolbina cavimarginata, n. sp.

Plate VIII, Figs. 7–9.

Size: Length, 1.35 mm.; hight, without flange, 0.72 mm., with flange, 0.85 mm.; greatest thickness (from tip to tip of ventral spines), about 1.2 mm.

In a side view the valves of this species are so much like *C. armata* that the two forms were at first confused. Interior and ventral views, however, are so strikingly different that the separation of the specimens proved unusually easy. Even on the outside the two forms present some differences. Thus, the flange is thicker and more extensive, the middle lobe relatively smaller, and none of the surface granulose. The main distinction, however, lies in the flange. In *C. armata* this is a simple plate, and so little developed that it scarcely hides the contact edges. In *C. cavimarginata*, however, it extends considerably beyond the edge and is supported at regular intervals by cross-walls, so as to form from ten to twelve deep rounded cavities. The end view is triangular in both, but in *C. cavimarginata* the lower part of the profile is much thicker than it is in *C. armata*.

Formation and Locality.—Same as the preceding.

Ctenobolbina insolens, n. sp.

Plate VIII, Figs. 10 and 11.

Size: Length, with flange, 1.88 mm.; without flange, 1.70 mm.; hight, without flange, 0.94 mm., with flange, 1.20 mm.

This also belongs to the *C. antespinosa* section of the genus, and stands in some respects intermediate between that species and *C. cavimarginata*. However, in views of the interior, the broad concave flange reminds even more strongly of *C. spiculosa*. The anterior ridge or tubercle of *C. antespinosa* is present; also a rounded knob in the post-cardinal angle, whose representative is more obscurely indicated in *C. cavimarginata*. The lobation of the central and posterior portions of the valves agrees better with the conditions prevailing in *C. cavimarginata* and *C. armata* than those marking *C. antespinosa*, but, instead of rising into curved spines, the lower portions of the posterior and anterior lobes are lost in the convex flange. The latter is peculiar in two respects, first, in the fact that its junction with the body of the valve is not distinguishable externally, and, second, in its limited extent and abrupt termination just in front of the middle of the vertical edge. The contact edges around the ventral half are finely toothed, a feature generally present in the typical section of the genus, but otherwise unknown in this section. The raised portions of the surface are more or less distinctly granulose.

Formation and Locality.—Same as the preceding.

CTENOBOLBINA GRANOSA, n. sp.

Plate VIII, Fig. 12.

Size: Length, without flange, 1.0 mm.; hight, with flange, 0.68 mm., without flange, 0.58 mm.

A rather small, convex and granulose species, with a subcentral sulcus extending only about half across the valves, a small longitudinal prominence just beneath it and a broadly scalloped, delicate frill overhanging the post-ventral edge. The latter is generally broken. *C. bispinosa*, from the Utica group at Cincinnati, and *C. punctata*, from the Niagara group, at Lockport, N. Y., are probably its nearest allies.

Formation and Locality.—Etched from limestone slabs containing an abundance of bryozoa received from Mr. Charles Schuchert, who collected them from the lower Helderberg formation, in Albany County, N. Y.

Ctenobolbina loculata, n. sp.

Plate VIII, Figs. 13 and 14.

Size: Length, 1.00 mm; hight, without flange, 0.54 mm., with flange, 0.60 mm.

The lobation in this small species is singularly like that of the Ordovician *C. crassa* and *C. subcrassa*, and the latter is simulated even to the possession of a small node in the upper and inner corner of the posterior lobe. The valves in *C. loculata*, however, are relatively longer and more equal-ended, while the construction of the flange is quite different. Instead of the thick, yet simple type of flange, pertaining to those species, we have here a strongly undulated plate supported by walls or pillars which divide the space intervening between the flange and the ventral edge into four subequal cavities. The undulations and extent of the flange remind of the preceding species, *C. granosa*, but in that form there are no cavities beneath, while the lobes are appreciably different, and the surface granulose instead of smooth.

Formation and Locality.— Rather rare in Safford's Maury shales of the Lower Carboniferous system, at Mt. Pleasant, Tennessee.

Kirkbya cymbula, n. sp.

Plate VIII, Figs. 15–18.

Size: Left valve: length, 0.97 mm.; hight, 0.50 mm.; thickness, 0.20 mm. Right valve: length, 1.10 mm.; hight, 0.54 mm.

Carapace oblong subquadrate, the hinge line long, straight or slightly convex, the ventral edge straight or slightly sinuate in its central portion, the anterior margin obliquely truncate and most prominent at the antero-cardinal angle; the posterior margin more rounded, though forming an angle where it joins the hinge line. Sides of valves enclosed by a thin raised rim, within which the surface is almost flat and traversed by more or less irregular longitudinal ribs, ten or eleven in number, separated by narrow furrows, of which each contains a row of small punctæ. Situated a little behind and more above the middle of the valve is a well-defined oval pit.

Though falling readily enough within the limits of the genus *Kirkbya*, as now understood, none of the species heretofore described seem to be enough like *K. cymbula* to require comparisons. The next described species, *K. germana*, is nearer than any other known to me.

Formation and Locality.—From the Devonian bryozoa bed, Falls of the Ohio.

Kirkbya germana, n. sp.

Plate VIII, Figs. 19–22.

Size: Right valve: length, 1.10 mm.; hight, 0.60 mm.; thickness, 0.23 mm. Left valve: length, 1.20 mm.; hight, 0.60 mm.; thickness, 0.25 mm.

This species, evidently, is closely related to *K. cymbula*, with which it is also associated. On close comparison we find that the outline is not exactly the same, the anterior extremity of the hinge line being less prominent and angular. The marginal rim is set a little further from the edge, and in the anterior part does not follow the outline of the valve, but bends downward from above, the junction with the lower portion forming an obtuse angle a little above the midhight. The space included within the marginal rim also is convex, instead of flat, while the longitudinally arranged ribs and pits are much larger, and, therefore, fewer, there being but six where *K. cymbula* has ten or eleven.

Formation and Locality.—Same as the preceding.

EXPLANATION OF PLATE VIII.

ALL THE FIGURES ARE MAGNIFIED TWENTY DIAMETERS.

Figs. 1 to 3.— Ctenobolbina subcrassa, n. sp., ... p. 180
1. A right valve.
2 and 3.— Lateral and ventral views of a left valve.
Stones River group, High Bridge, Ky.

Fig. 4.— Ctenobolbina obliqua, n. sp., ... p. 180
A right valve retaining some of the flange.
Trenton group, Kenyon, Minn.

Fig. 5.— Ctenobolbina spiculosa, n. sp., ... p. 181
Nearly perfect right valve.
Hamilton group, Falls of the Ohio.

Fig. 6.— Ctenobolbina armata, n. sp., ... p. 181
A right valve showing the usual characters of the species.
Hamilton group, Falls of the Ohio.

Figs. 7 to 9.— Ctenobolbina cavimarginata, n. sp., ... p. 182
7 and 8.— Lateral and posterior views of a left valve.
9.— View of interior of another left valve.
Hamilton group, Falls of the Ohio.

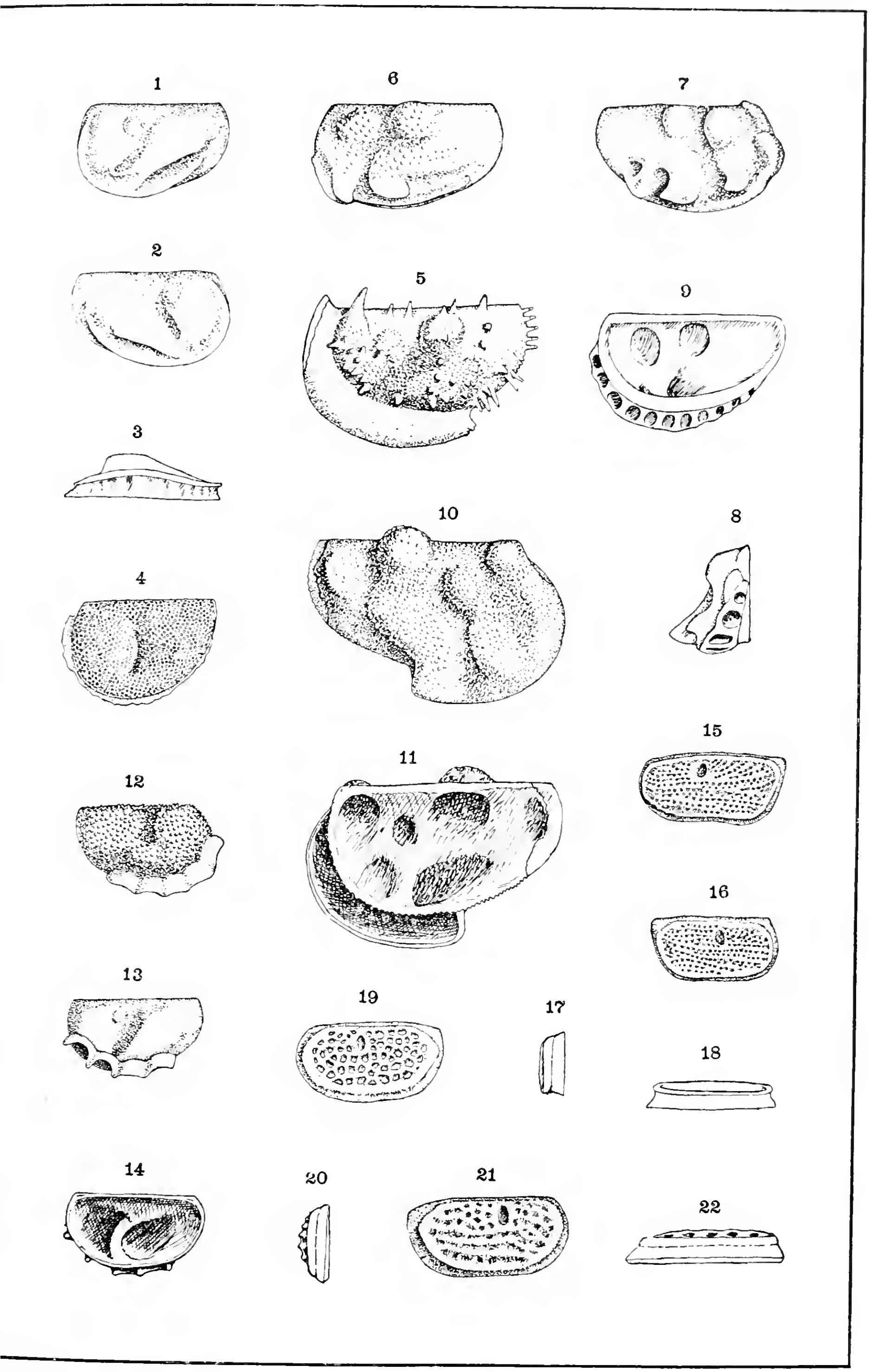
Figs. 10 and 11.— Ctenobolbina insolens, n. sp., ... p. 182
10.— Exterior of a left valve.
11.— Interior of another left valve.
Hamilton group, Falls of the Ohio.

Fig. 12.— Ctenobolbina granosa, n. sp., ... p. 183
A perfect left valve.
Lower Helderberg group, Albany County, N. Y.

Figs. 13 and 14.—Ctenobolbina loculata, n. sp., ... p. 184
13.—Exterior of a right valve, apparently perfect.
14.—Interior of a left valve.
Kinderhook group, Mt. Pleasant, Tenn.

Figs. 15 to 18.— Kirkbya cymbula, n. sp., ... p. 184
15.— A right valve.
16.— A left valve, relatively shorter.
17 and 18.— End and ventral views of same.
Hamilton group, Falls of the Ohio.

Figs. 19 to 22.— Kirkbya germana, n. sp., ... p. 185
19.— A right valve.
20.— End view of same.
21.— A left valve, relatively longer.
22.— Vertical edge of same.
Hamilton group, Falls of the Ohio.



Ulrich Paleozoic Ostracoda.

ARTICLE XX.—THE GENUS SCAPHOIDEUS.*

By Prof. Herbert Osborn, Ohio State University, Columbus.

The genus *Scaphoideus* was founded by Uhler in 1889, and made at that time to include the *immistus* of Say, and the newly described species *intricatus*, *jucundus*, and *consors*. During the same year Provancher described *auronitens*, and the number has been further increased by descriptions by Van Duzee and the writer.

As material is in hand for the characterization of several new forms, it seems a suitable time to bring together a short resumé of the species heretofore described, and attempt a synopsis that shall indicate the affinities in the group. Doubtless additional species will come to light, but it is believed that a sufficient number are in hand to give a basis for a natural grouping, and to indicate the character of the fauna in the genus.

The generic characters, as given by Uhler, are "Form of Phlepsius lacerdæ Sigt. Head triangular, flat above, vertex almost as long as the width between the eyes, subacuminate at tip, the base deeply sinuated; front longer than wide, deltoid, with the sides near the tip moderately curved, tylus liguliform; cheeks broad, curved, expanded to behind the middle of the eye, acutely tapering at tip and hardly enclosing the entire lora, the lora diagonal, acute at each end. Antennæ long and slender. Pronotum sublunate, more curved anteriorly than sinuated posteriorly. Wing-covers moderately narrow, longer than the abdomen, curved, valvate, the costal areole long, narrow, destitute of cross veins, followed by a gradually widening cell, beyond this are four apical cells of large size and mostly broad triangular figure; wings with the two apical middle areoles long and narrow, narrowing at base towards the cross-vein. Abdomen moderately long and narrow."

As so defined the genus may include species which approach quite closely to *Deltocephalus*, or, as suggested by

*Contributions from the Department of Zoology and Entomology of the Ohio State University, under the direction of Prof. Herbert Osborn, No. 3.

Uhler, to *Platymetopius* of the forms with short vertex. Indeed it seems probable that the genus is an offshoot of *Deltocephalus*, which view is further strengthened by the fact that it is strictly American in its distribution, and has a much more restricted distribution than Deltocephalus.

On the other hand some of the species show affinities with *Paramesus*, *Eutettix*, and *Phlepsius*.

As used in this paper the characters of most importance are the deeply sinuate occiput, the long antennæ, the large loræ, approximate to margin of cheeks (except in *sanctus* group), the narrow vertex, the width and length of which are usually about equal, and the recurved nodal or costal veins. The clypeus is usually widened at tip, and for the more typical members of the genus the outer ante-apical cell is narrowed behind, becoming pointed, and, in some species, stylate.

The characters found to be most available in separating the species are in the genitalia, the elytral veins, especially those of the nodal region, and the shape of the vertex. The latter are perhaps most constant, and have been relied on where other characters have seemed too variable to afford definite results. The separations into the principal divisions are easily made, and the affinities indicated seem well fixed. Not so much can be said regarding the minor divisions, especially the species grouped together in the *immistus* division. The use of the claval veins, though affording the best basis apparent in material in hand, may be found insufficient in larger series. It is hoped that they may at least serve a useful purpose in facilitating the recognition of several species, the precise limits of which are rather difficult to define.

It appears to me that the affinities of the genus are more nearly with Deltocephalus and Platymetopius than with the *Athysanini* of Van Duzee, for while the second cross vein is usually wanting, the eyes are placed near together, so the vertex is but little wider than long, and in some cases even longer than wide.

The species occur in wooded places, and probably occur for the most part on trees or shrubs, as those species for which

any record of food plant is given include Cratægus, oak, grape, spice bush, witch hazel, etc., but in very few cases have food plants been carefully determined, especially for the larvæ.

I have had for study collections from the National Museum, the Iowa State College, and some fine series of specimens from Mr. E. D. Ball, Mr. E. P. Van Duzee, Mr. Otto Heideman, and Prof. R. H. Pettit, for all of which I take the opportunity to express my obligations. This, with the material in my own and the Ohio State University collections, forms an aggregation of several hundred specimens.

The genus is strictly American, and the more typical members, *immistus* and allies, are found mainly east of the Rocky Mountains; *scalaris* and allies cover a wider range, and with *fasciatus* extends the range of the genus into subtropical region.

SYNOPSIS OF THE SPECIES.

A Loræ remote from the margin of the cheeks; common elytral picture cruciate; claval vein straight, meeting suture at acute angle.

a Face with two dark fasciæ, beside frontal arcs, vertex obtuse.

b Length 4mm. vertex obtuse .... *fasciatus* n. sp.

bb Length 5mm. vertex subacute .... *sanctus* Say

aa Face yellow without cross bands, vertex acute.... *picturatus* Osb.

AA Loræ contiguous to, or merging with, border of cheeks, elytral picture not cruciate, outer claval vein curved or hooked at distal end.

a post nodal cell slightly widened posteriorly, outer ante-apical cell with nearly parallel sides, nodal vein or veins not reflexed.

b Post-nodal cell without cross veins, ♂ plates prolonged into long flaccid or filamentous tips.

c Nodal vein arising from discal cell.......... *auronitens* Prov.

cc Nodal vein arising from ante-apical cell.

d Vertex flat with transverse impressed line, edges acute.............................. *jucundus* Uhl.

dd Vertex convex, no impressed line, edges rounded.

e Vertex wider than long, obtuse or rounded.

f Vertex sub-acute, size large......... ......*consors* Uhl.

ff Vertex obtuse or rounded, size small..*mexicanus* n. sp.

ee Vertex as long or longer than wide, acute..*scalaris* Van D.

bb Post-nodal and costal cells with cross veinlets, elytra with numerous ramose lines in the cells .... *lobatus* Van D.

aa Post-nodal cell much widened at distal end, outer anteapical narrowed posteriorly acute or stylate, ♂ plates not prolonged in flaccid tips.

b Outer claval not strongly hooked at distal end; cross nervure to claval suture indistinct or wanting.

c Outer claval sinuate approaching inner near its middle.

d Light ochreous, ♀ ultimate ventral segment truncate or slightly notched.................... ......*ochraceus* Osb.

dd Marked with fuscous, ♀ ultimate ventral segment produced................................. .*productus* n. sp.

cc Outer claval nearly straight and parallel to inner, curved at tip.

d ♀ ultimate ventral segment carinate toothed at middle, *carinatus* n. sp.

dd ♀ ultimate ventral segment not carinate or toothed.

e Head and pronotum ivory white or yellowish, *intricatus* Uhl.

ee Head and pronotum with darker areas luteous or fulvous, *luteolus* Van D.

bb Outer claval strongly hooked at distal end usually with distinct cross nervure from outer claval to claval suture.

c No distinct cross vein between claval veins; colors gray or brown marked with fuscous ....*immistus* Say

cc Usually a distinct cross vein between the clavals.

d Outer claval approximating claval suture posteriorly; face black..................................*melanotus* n. sp.

dd Outer claval remote from claval suture posteriorly.

e Vertex obtusely angulate; apex of elytra fuscous or black, *obtusus* n. sp.

ee Vertex more produced, sub acute; elytra entirely gray, *cinerosus* n. sp.

Scaphoideus fasciatus n. sp. (Plate X, Fig. 1).

Elytral picture similar to that of *sanctus* and *picturatus*. Face with two conspicuous transverse fuscous bands continued on sides. Length to tip of elytra, ♀ and ♂ 4 mm.

Vertex impressed, rounded in front, the margin obtuse, length three fourths of width, space between eyes and eye on pronotum equal; front at apex equaling base of clypeus; clypeus elongate, scarcely widened at tip; loræ distant from margin of cheeks, oval, the border touching clypeus and front, evenly but slightly convex. Pronotum very convex in front, truncate behind, lateral margins very short. Elytra with narrow appendix, the post-nodal cell widening rather sharply behind.

Color: Vertex white, two dark points near apex and two lighter quadrate or transverse fuscous spots midway from

base to apex. Face white, two marginal bands above and two broad fuscous fascia across, one including antennal pits and continued below eyes across pleural pieces of thorax, the other including apical half of clypeus, lower part of cheeks and continued on anterior coxae. Pronotum white with faint infuscation, scutellum white, basal angles dark; elytra when closed with a common fuscous cruciate mark as in *sanctus*, but the hinder bars extend only to the middle of the disk, from whence a fuscous band runs to the suture at apex of clavus, the entire cross bordered with dark fuscous or black; the white base of the clavus parallels the edge of the scutellum, a white bar crosses the clavus obliquely near tip, and hyaline discal and apical spots are bordered with white; post-nodal and two or three apical cells fuscous. Beneath whitish ventral segments bordered with fuscous, and with a fuscous median line.

Genitalia: ♀ last ventral segment concavely excavated; pygofer and ovipositor short, pygofer embrowned at base. ♂ valve short; plates oval, short, half as long as pygofer bluntly rounded at apex with a discal brown fascia.

Four specimens from Port au Prince, Haiti, through the kindness of Mr. E. D. Ball. One specimen ♂, Frontera, Mexico (C. H. T. Townsend) is also referred here.

While the material in hand presents differences that have been thought sufficient to separate this form from the *sanctus* Say as referred by Van Duzee, it is possible that additional material may connect them, when the range of the species would cover the Gulf States, Atlantic coast of Mexico, and West Indies. However, the vertex is much more obtuse than in Florida specimens, especially of males, and the size averages much smaller.

SCAPHOIDEUS SANCTUS Say.

Jassus sanctus Say. Jour. Acad. Nat. Sci. Phila., Vol. VI., p. 306 (1831).
Complete writings ed. by Le Conte, Vol. II. p. 383 (1869).
Walker, Homop. Vol. IV. p. 1164 (1852).

Scaphoideus sanctus, Van Duzee. Cat. Trans. Am. Ent. Soc., Vol. XXI., p. 300.

"5. J. sanctus—Hemelytra white, with a common brown cruciate mark. Inhabits Indiana. Body yellowish white;

head sub-acute, with two minute fuscous points near the tip, and an undulated line on the anterior edge; thorax dusky across the middle; hemelytra white, somewhat opalescent, with a common large cruciform mark on the middle composed of brownish spots with blackish edges, and including a whitish common spot; tip with large spots; venter with a dusky band and small lateral spots; feet immaculate. Length to tip of hemelytra nearly one-fifth of an inch." (Say.)

The form which Van Duzee has referred to *sanctus* Say occurs in Florida, Mississippi, and Texas, but I know of no specimens from the latitude of Indiana, the type locality. The specimens which formed the basis of Van Duzee's reference agree in most respects with Say's description, but possess two dark fasciæ across the face, a point not mentioned in Say's description. There are also fuscous annulations on the legs, which would seem to be excluded by the "feet immaculate" of Say's description. On the other hand my *picturatus* occurring nearer the type locality agrees very well in these respects, but has the vertex entirely too prominent and sharp to be called "sub-acute." It seems, therefore, the better plan to follow Van Duzee's reference until sufficient material is available to determine positively that it should be changed. A change, if not supported by future collecting in the type locality of Say's species, would only add greater confusion, which should be avoided if possible.

The specimens of this form in hand, and which include the Florida specimen of Van Duzee's reference, have the head sub-acute with four distinct transverse spots on the vertex behind the transverse impression, and in some there is a trace of a minute pair of apical dots. The band on prothorax is finely transversely irrorate in female, and broken into four oval black spots in the male. The last ventral segment of female is very short, bisinuate, and with an elevated polished black area at middle. The male vertex is slightly more produced, and the genital valve is very small, oval, the plates short and oval with a dark submargin. As compared with the Haitian species, *fasciatus*, the vertex is much more acute, and the marks on head and pronotum more distinct. Specimens from Texas show some tendency to vary between

these forms, and it is possible intergrades may be found in the Mexican fauna.

One specimen from Florida in the Van Duzee collection, three from Texas, collected by Aaron, in collection of Iowa State College, one male from Florida from Prof. H. A. Gossard, and one male from Jacksonville, Fla., from Mr. Heidemann, represent the material in hand.

SCAPHOIDEUS PICTURATUS Osborn (Plate IX, Fig. I)

Scaphoideus picturatus Osb. Proc. Iowa Acad. Sci., V., p. 243 (1898).

Color pattern very similar to *sanctus*. Head more sharply angular, reflexed veins less oblique or indistinct. Length to tips of elytra, female 5 mm., male 4 mm.

Vertex sharply angulate at the tip, as long as width between the eyes, and nearly twice as long at middle as next eye. Front very slightly widening next antennæ, tapering uniformly to base of clypeus; clypeus with sides parallel, base and apex convex; loræ small, suboval; genæ roundingly angulate below the eyes. Pronotum sharply arcuate in front, truncate behind, lateral margin extremely short; scutellum small, the elytra with the post-nodal veinlets irregular, the first either absent or not reflexed, the second strongly reflexed, the middle and inner anteapical cells with distinct or obsolete cross nervures.

Color: Vertex, anterior part of pronotum, scutellum, face, pectus, venter and margin of abdomen above, yellow or greenish-yellow; two minute points next each eye, two short oblique lines near tip, and a very slender median line on vertex, three or four strongly curved arcs on the front, the margins of the olivaceous areas, an oblique band near the tip, and a submarginal border on the elytra, fuscous. The elytra are fusco-olivaceous, interrupted with ivory white as follows; a broad oblique band on the base of corium and clavus paralleling the sides of the scutellum, a discal spot at forking of the first sector, a commisural spot and a broad band across the base of the anteapical cells. The nervures are white on the white portions and also in the fuscous part at apex.

Genitalia: Female, ultimate ventral segment short, slightly notched on the median line; pygofers thickly set towards tip

with rather fine bristles; male, valve small; plates long, tapering gradually to the obtuse tip, exceeding the short pygofers. Both plates and pygofers are finely ciliate with pale hairs.

One female was received from Prof. H. Garman, Lexington, Ky., and one male was collected at Burlington, Iowa, September 5, 1897. Specimens are in hand from St. Louis, Mo., and West Virginia.

I have noted under *sanctus* the possibility that this form, since it comes nearer the type locality and agrees better in some points, may in reality be the form to which Say's description applies.

SCAPHOIDEUS AURONITENS Prov. (Plate X, Fig. 2).

Scaphoideus auronitens Provancher. Petite Faune Canadienne, III, p. 277 (1889)

Van Duzee Catalogue. Trans. Am. Ent. Soc., XXI., p. 301.

Osborn and Ball. Proc. Ia. Acad. Sci., IV., p. 232 (record).

Nodal vein arising from discal cell. Last ventral segment of female deeply cleft. Length to tip of elytra, ♀, 4.50–5 mm; ♂, 4.50 mm.

Vertex slightly wider than long, sub-acute. Front narrowing uniformly, clypeus long, loræ reaching margin of cheeks. Nodal vein arising usually well in front of outer anteapical cell and from the discal cell.

Color light yellow, the vertex and front margin of pronotum with prominent orange red transverse spots. A short transverse line and a broader line parallel to margin on upper margin of vertex, black.

Genitalia: Last ventral segment of female cleft to near its base, each lobe long, rounded at tip; pygofer scarcely exceeded by the ovipositor with short, brown bristles. Male valve small, short, plates elongate triangular, an impressed line parallel to outer margin, and with a long, slender filament finely ciliated reaching far beyond tip of pygofers.

This species was described from Canada, and Van Duzee gives Canada, New York, and Mississippi for its distribution. It occurs abundantly at Ames, Iowa, during July and August, and I have it from Columbus, Ohio. Specimens are also in hand from Washington, D. C. (Heidemann), so that it may be expected to occur generally from Canada to the gulf, and

west to the plains region. It is a well marked species, and apparently subject to very little variation. While in some respects similar to *jucundus*, and apparently referred to by Uhler as a variety of that species, the striking orange marks, the deeply cleft female segment, and the point of origin of the nodal vein make it easily separable.

Scaphoideus jucundus Uhler

(Plate IX, Fig. 2; Plate X, Fig. 3),

Scaphoideus jucundus Uhler. Trans. Md. Acad. Sci., I, p. 34 (1889), Van Duzee, Can. Ent. XXI, p. 11, 1889 (mention).

Van Duzee. Trans. Am. Ent. Soc., XXI, p. 300.

Fulvous, elytra with numerous milky oval spots. Nodal vein arising from the anteapical cell. Length to tip of elytra, ♀, 6–6.25 mm., ♂, 5–5.25 mm.

Vertex flat, slightly depressed, acute, edges thin; front narrowing uniformly to clypeus. Elytra with claval veins but slightly curved apically, and the transverse vein between outer claval and claval suture indistinct.

Color: Head, thorax and elytra rich, tawny yellow, a central line on vertex, on pronotum, and oval spots on elytra, milky white. An obscure line bordering anterior margin of vertex, and a more distinct one bordering the upper margin of front, black.

Genitalia: ♀, last ventral segment longer at middle than at sides, nearly uniformly curved; pygofers short, with scattered brown bristles a little thicker toward the tip. ♂, valve narrow, short; plates slender, acuminate, about half as long as pygofers, with flaccid prolongations which reach about to tip of pygofers.

Uhler does not state locality, but his description was probably from specimens collected in Maryland. Van Duzee gives records for Canada and New York. It was taken abundantly at Ames, Iowa, in August and July. Specimens in hand from the National Museum are marked "St. Agnes," "Sept.," "Oct.," and "Nov.," on "Oak." One from Washington, D. C., Oct. (Heidemann).

The vividly colored variety mentioned by Uhler would seem to correspond with *auronitens* Prov., the different structural characters of which have been noted.

SCAPHOIDEUS CONSORS Uhler. (Plate X, Fig. 4).

Scaphoideus consors Uhler. Trans. Md. Acad. Sci., I, p. 36 (1889), Van Duzee, Catalogue Jassoidea, Trans. Am. Ent. Soc., Vol. XXI, p. 300.

Ochreous brown, marked with white and fuscous. Vertex wider than long, angulate. Length to tip of elytra 5.25–5.75 mm.

Head rather obtusely angulate in front; vertex, length five-sixths of width, front with sides nearly parallel, narrowing sharply to apex; clypeus widening at tip; loræ broad, outer border semi-circular, reaching to or merging with border of cheek. Nodal vein of elytra arising from outer anteapical cell.

Color: "Dull, pale, clay brown inscribed with white and fuscous."

Genitalia: ♀, last ventral segment long, hind margin sinuate, scarcely notched at center, lateral angles rounded; pygofers moderately robust, with light brown bristles scattered over the surface, and more numerous near tip.

Specimens referred to this species are in hand from New York (Southwick), Washington, D. C. (Mally), and from National Museum, "Relay Station, Md.," and "Texas (Belfrage)."

While it is difficult to locate very positive characters, there seems to be, as stated by Van Duzee, sufficient reason to separate it from *scalaris*. However, my material of typical *consors*, or of specimens that would show its affinities with other forms, is too scanty to permit of definite conclusions.

Var. unicolor. n. var. (Plate X, Fig. 5, 5*a*), similar in size and shape to *consors*, but of a dense brown color with markings nearly or entirely obliterated. Face uniform brown, pectus and venter dark brown or fuscous. Ocelli red. Elytra dark brown, nodal vein broadly and densely marked with fuscous. The last ventral segment of female is shorter, more truncate, and the pygofers short, more robust, and bristles confined more to margin and tip. The ♂ valve is large, rather narrow, plates elongate triangular, outer margin slightly convex, the flaccid tips rufous and reaching to beyond tip of pygofers.

One specimen, Berkeley Springs, W. Va., and three, Decatur, Ala., received from Mr. E. D. Ball.

The specimens in hand taken alone might be considered a distinct species, but while there is a decided difference in genitalia from what I conceive to be typical *consors*, the shape of the head, and the probability that absence of markings is due to suffusion of color, makes it seem best to consider it, for the present at least, as a variety.

SCAPHOIDEUS MEXICANUS n. sp. (Plate X, Fig. 6, 6a, 6b.)

Resembles *scalaris*, but with vertex more rounded in front and the genitalia elongate. Length to tip of elytra ♀, 5.25 mm: ♂ 5 mm.

Vertex wider than long, length five-sixths of width, rounded in front, and margins rounded over to cheeks. Front narrow; clypeus elongate and widened at tip; loræ long, reaching almost to margin of cheek. Pronotum wide, twice as wide as long, lateral margin rather short, rounded, hind margin truncate or scarcely emarginate. Clavus with cross veins from the outer vein to claval suture conspicuous, apical ends of the claval veins distinctly bent, nodal vein arising from outer anteapical cell.

Color and markings like *scalaris*; vertex yellow with fuscous lines in front and two rather prominent spots near center, curved light bands less distinct than in *scalaris*: front yellowish with suture and the semi-arcs of front fuscous. Elytra subhyaline with elongate whitish spots on clavus, discal and inner anteapical, which alternate with fuscous fasciæ. Apical cells with fuscous spots and margin.

Genitalia: ♀, last ventral segment long, lateral angles rounded, apex truncate; pygofers long, slender, a few light bristles along the margins, and larger darker ones near the tip. ♂, valve short but distinct, hind border with obtuse process at center; plates narrow, elongate, triangular, outer border straight, reaching about three-fourths the length of the pygofers before becoming flaccid, the flaccid tips extending beyond the tip of pygofer.

Four specimens collected at Orizaba Mex. (H. O.), January, 1892, and one specimen Frontera, Tobasco, Mex. (Townsend).

In shape of vertex this comes nearer *consors*, but in other points it more closely resembles *scalaris*. *Consors*, *scalaris*, this form, and the var. *unicolor* of *consors* form a closely related

group, and very likely may prove to be geographical forms. This may be determined by comparisons of full series of material for the intermediate territory or by breeding, but until so proven it will be more satisfactory to retain their distinctions.

SCAPHOIDEUS SCALARIS VanDuzee. (Plate X, Fig. 7, 7a, 7b).

Scaphoideus scalaris VanDuzee. Entomologica Americana, VI, p. 51, 1890. Catalogue Trans. Am. Ent. Soc., XXI., p. 300.
Osborn & Ball. Proc. Iowa Acad. Sci., IV, 232 (Record).

More slender than *consors*, vertex as long or longer than wide, apex prominent, though obtuse at tip. Length to tip of elytra 5 mm.

Vertex long; as long as width, and in some cases one-fifth longer; front narrow, sides nearly straight and parallel; clypeus widening gradually to tip; loræ long, reaching margin of cheek. Pronotum half as long as wide, hind border slightly concave. Cross veins between outer claval and suture obscure.

Color, light testaceous, intricately marked with fuscous, ocelli white.

Genitalia: ♀, last ventral segment long, narrowed toward tip, lateral angles rounded, apex truncate or slightly excised; pygofer rather broad at base. ♂, valve very small or hidden, plates slender, triangular, reaching to middle of pygofers, their flaccid tips ciliate at end and reaching to tip of pygofers.

A very abundant species in Iowa and west to the Pacific coast. Numerous specimens collected at Ames, Iowa, July, August, September and October. One Burlington, Iowa. One Columbus, Ohio; Phoenix, Ariz., May 9, Mex., Pullman, Wash. (from E. D. Ball), California (VanDuzee), Los Angeles, Cal. (Coquillett), Santa Cruz, Cal. (Koebele), Clinic Mts., Ariz. (Hubbard).

While there appear to be some slight variations, I am unable to fix upon any distinctive and permanent character to separate the representatives from Mississippi valley and Pacific region. The specimens from Pullman, Wash., are a little larger, and, perhaps, more brightly marked than the average from Pacific coast, but not more so than many individuals that can be selected either from California or Iowa.

SCAPHOIDEUS LOBATUS VanDuzee. (Plate X, Fix. 8.)

Scaphoideus lobatus VanDuzee. Bul. Buffalo Soc. Nat. Hist, V, No. 4, p. 211 (1894).

Catalogue Trans. Am. Ent. Soc., XXI, p. 300.

Osborn & Ball. Proc. Iowa Acad. Sci., IV, p. 232 (Record).

Light yellow or white, with black spots and lines. Length, ♀, 6 mm.

Vertex considerably wider than long, very obtusely angulated in front, with scattered black, dark spots, the marginal line broken into spots, or forming a curved line on either side. Costal cell with numerous dark cross veinlets.

Genitalia: ♀, last ventral segment long at middle, nearly truncate, very slightly notched. ♂, valve "small, brown; plates narrow, their slender recurved tips brown and fringed with long white hairs."

This species was described from two specimens from Lancaster, N. Y., and two from New York City. It was taken at Ames, Iowa, by Mr. E. D. Ball, August 7, 1897, and August 13, 1897. I have one specimen from Madison, N. J., taken August 6, 1898, and one from Mr. VanDuzee, taken at Gowanda, N. Y., August 18, 1898.

This species occupies a position by itself, and appears to have affinities with either Eutettix or Paramesus. The postnodal cell is narrow, and the presence of cross veinlets in the costal cell are exceptional. However, the shape of vertex and front scarcely permit its reference to a different genus, unless one be created for its reception.

SCAPHOIDEUS OCHRACEUS Osborn. (Plate IX, Fig 3.)

Scaphoideus ochraceus Osborn. Proc. Iowa Acad. Sci., V, p. 242, 1898.

Tawny ochraceous and pallid with most of the elytral nervures fuscous. Length to tip of elytra, ♀ 6 mm., ♂ 5 mm.

Vertex as long as width between the eyes, nearly as long as pronotum, the margin angularly rounded; front, narrow; margins slightly concave next the antennæ, tapering uniformly to base of clypeus, which it equals in width. Clypeus twice as long as width at base, broadening to the apex, which is distinctly truncate; loræ oval, sub-angulate at tips, twice as long as wide; genæ broad, slightly concave below eyes

and sub-angulate on margin, forming a narrow margin below loræ. Elytra with costal veinlets very oblique, as in *immistus*, the first originating at or just in front of the transverse veinlet; the second near the middle of the outer anteapical cell; the third at the end of the anteapical cell, but not touching the apical veinlet. In one specimen an extra oblique vein occurs between first and second. Claval vein curved, no cross vein to suture.

Color: Vertex yellow with a broad ochraceous or ochraceous-rufus band across the disk, the median portion forming a short curve and reaching the width of the band toward the apex, sometimes almost interrupted; pronotum with two large spots on the anterior margin near the middle; the posterior half, except narrow median line, two large lateral spots and a slightly fainter median stripe, a wide border to nearly all the nervures and the apex of elytra, ochraceous; a spot at end of inner claval nerve, a short line at end of outer claval nerve, an elongate spot at end of clavus, a spot in inner discal area, interrupted lines on the nervures most conspicuous on the reflexed veinlets and next the costa and a subapical border, fuscous; the elytral cells whitish hyaline.

Genitalia: ♀, ultimate ventral segment long, the posterior border straight or very slightly produced at the middle. Pygofers full, polished, with marginal and terminal bristles, the latter strong; ♂, valve very short, transverse; plates broad, roundingly narrowing to obtuse tip with weak marginal bristles; pygofers rather broad, extending half their length beyond the plates and set with long, stiff bristles.

Collected at Ames, Iowa, from July 29 to August 13.

Specimens have also been examined from Gowanda, N. Y. (VanDuzee) and western Pennsylvania (Wirtner).

While this species has the general color of *jucundus* it differs from that species very distinctly in the oblique reflexed veinlets, and in having the transverse band on the vertex, instead of the two parallel spots. From *immistus*, *intricatus*, and *luteolus*, which it resembles in venation, it differs in color and size.

Scaphoideus productus n. sp. (Plate X, Fig. 9, 9 a, 9 b.)

Gray brown, vertex with heavy fuscous crossband produced

at center. Female ventral segment produced. Length: ♀, 6 mm.; ♂, 5.50 mm. to tip of elytra.

Vertex rather acute, its length nearly equal to its width, front with margins slightly sinuous, apex narrowing slightly but abruptly to clypeus, clypeus narrow, widening abruptly at apex; loræ narrower than in *carinatus*, touching margin of cheek. Pronotum lunate, hind border slightly concave. Elytra with claval veins strongly curved at tip, outer anteapical cell pointed, scarcely stylate, usually three recurved veins arising from anterior part of anteapical cell.

Color: Vertex yellowish, a broad fuscous band produced at middle to nearly meet the broken marginal band and shading to light brown posteriorly; face dark above, lighter on lower half; the marginal band, and submarginal arc black, the frontal semi-arcs fuscous and lower part of front lighter, the cheeks under antennæ and the apices of loræ fuscous, as also the sutures; pronotum yellowish, with fuscous lateral patches; elytra whitish or hyaline, with fulvous areas on discal and apical cells, and fuscous patches on clavus inner discal cell, on nodal and apical veins and apical submargin.

Genitalia: ♀, last ventral segment long, produced at middle, lateral angles rounded, pygofers reaching about to tip of ovipositor, with a patch of black bristles near tip and whitish bristles near middle; ♂, valve short; plates broad short, obliquely truncate, flat, lateral margin reflexed, less than half the length of the large pygofers.

Described from seven ♀s and two ♂s of which three females were taken at Ames, Iowa, August 3, 1896, August 7, 1897, and October 14, 1896. One at Sioux City, July 7, 1897. Three ♀s and one ♂ Onaga Kans. (Crevecour) and one ♂ from Kentucky (Garman).

While this species approaches *carinatus* in size and general appearance, it is quite distinct from it in the genitalia, and also differs in the shape and markings on vertex and clavus.

SCAPHOIDEUS CARINATUS n. sp. (Plate X, Fig. 10, 10 a, 10 b.)

Large, light gray, with a heavy cross band on vertex; last ventral segment of female, with a strong carina and projecting tooth. Length: ♀, 6.50 mm. to tip of elytra.

Vertex subangulate. Length, five-sixths of width, one-half longer at middle than next the eye; front narrow, margins nearly straight; clypeus widening at tip; loræ large, broad, scarcely reaching border of cheeks; pronotum a little more than twice as wide as long, the hind border scarcely emarginate; elytra broad, the cross vein between outer claval vein and suture obsolete, first anteapical triangular, pointed behind, scarcely stylate.

Color; Dark gray for head and prothorax, light gray for elytra; vertex with a conspicuous transverse fuscous band projected forward at middle, and a heavy fuscous line parallel to the anterior margin each side; face whitish with fuscous borders to the sutures; pronotum grayish brown with fuscous spots; elytra whitish, with fuscous veins, the nodal and apical broadly bordered, the claval veins at the strong apical curve crossed by a dark dash, the apex fulvous with a broad marginal fuscous border; legs whitish, with anterior femora blackish, and the usual points on posterior tibiæ and tarsi; abdomen whitish, with blackish washes on segments.

Genitalia: Last ventral segment of ♀ broad, with a strong carina on median line produced into a sharp spur beyond the hind margin.

This large and quite distinct species apparently belongs to the eastern part of the country, as of the three specimens, all of which are females; one is from Hanover, N. H. (C. M. Weed); one from New Jersey (C. W. Johnson); and one from Hamburg, N. Y. (E. P. VanDuzee), the last collected July 31, 1898.

Scaphoideus intricatus Uhler.

Scaphoideus intricatus Uhler. Trans. Md. Acad. Sci., I, p. 34, 1889.

VanDuzee Catalogue, Trans. Am. Ent. Soc., XXI, p. 300, 1894.

Osborn and Ball. Proc. Iowa Acad. Sci., IV, 232 (Record).

Vertex scarcely as wide as long, with very faint transverse band and marginal line. Beneath white, except a series of dots on lateral margin of abdomen and a central patch on last ventral segment of female.

♀, last ventral segment truncate; pygofers rather long with small dusky patches near the tip each side, a few small

scattered white bristles, sometimes embrowned; coxæ and pleural pieces sometimes with fuscous spots.

Females of this species are in hand from Ames, Iowa, taken July 30, 1896, "Onaga Kans," received from Mr. E. D. Ball. "Albion, N. Y., August 27, 1898," from Mr. VanDuzee; Columbus, Ohio, October 10, 1898; and West Point, Neb. (Bruner).

Uhler does not describe the male, but specimens which seem to belong here, and one of which has been so placed by Mr. VanDuzee, may be characterized in this connection.

♂, Length to tip of elytra 4 mm. Very light, apparently immature; vertex borders tinged with fulvous; valve short; plates elongate, nearly as long as pygofers; outer margins subangulate, sides somewhat reflexed near base, with long white cilia on margin, and a bunch of black hairs beyond their tip on pygofers.

One specimen, Agricultural College, Michigan, having date August 3, 1892, kindly loaned me by Prof. Pettit, and four specimens from Ames, Iowa, bearing dates in July and August of 1896 and 1897, collected by Mr. E. D. Ball. These specimens have a peculiarly immature look, but agree so exactly that they can hardly be considered as such. Their very small size, as compared with ♀ *intricatus*, raises the question whether they are actually males of this species, but the color and markings agree better here than with any other species and the specimens mentioned by Van Duzee from the Agricultural College, Michigan, may have been taken together.

According to Uhler, *intricatus* occurs on Crataegus bushes from early August to late October in Maryland, Virginia, and New Jersey.

SCAPHOIDEUS LUTEOLUS Van Duzee. (Plate X, Fig. 11, a, b, c.)

> *Scaphoideus luteolus* VanDuzee, Bull. Buffalo Soc. Nat. Hist., Vol. V, p. 210. Catalogue Trans. Am. Ent. Soc., XXI, p. 300.
> Osborn & Ball. Proc. Iowa Acad. Sci., IV, p. 232 (Record).

"Form and size of *auronitens*: Length, 4 mm."

Vertex scarcely as long as wide, subangulate at apex, margined with a fine line and with a brown transverse band

between the eyes, which fades out only at hind border of the head.

♀, last ventral segment produced, angles retreating, pygofers long and slender, not reaching the tip of the ovipositor. ♂, valve broad, short; plates large, tapering to a sharp point and reaching about three-fourths the length of the pygofers.

Described from Anglesea, N. J. (Smith), and New York City (Southwick).

Specimens also referred to this species from Ames, Iowa, (Iowa State College collection), and from Urbana, Ill. (McElfresh). While the types which have been in hand for examination and some of the other specimens seem quite distinct, there are others evidently belonging here, which vary toward *immistus*. The male plates, however, seem to furnish a good character. One specimen (Baker collection) is labeled "Willow, September 8."

SCAPHOIDEUS IMMISTUS Say. (Plate IX, Fig. 4; Plate X, Fig. 12.)

Jassus immistus Say. Jour. Acad. Nat. Sci., Phila., VI, p. 306 (1831).

Jassus immistus Harris. Geology of Mass., 2d Ed., p. 580 (1835).

Jassus immistus Walker. Homop., IV, p. 1163 (1852).

Jassus immistus Say. Complete writings edited by Leconte, Vol. II, p. 382 (1869).

Jassus immistus VanDuzee. Canadian Entomologist, XXI, p. 11, (1889).

Scaphoideus immistus Uhler. Trans. Md. Acad. Sci., I, p. 33, (1889).

Scaphoideus immistus Provancher. Pet. Faune. Ent. Can., III, p. 276, (1889).

Scaphoideus immistus VanDuzee. Psyche., V., p. 389 (1890).

Scaphoideus immistus Harrington. Ottawa Naturalist, VI, p. 32, (1892).

Scaphoideus immistus Osborn. Proc. Iowa Acad. Sci., I, Part 2, p. 125, (1892).

Scaphoideus immistus Southwick. Science, XIX, p. 288, (1892).

Scaphoideus immistus VanDuzee. Bull. Buffalo Soc. Nat. Sci., V, p. 190, (1894).

Scaphoideus immistus VanDuzee. (Catalogue) Trans. Am. Ent. Soc., XXI, p. 300, (1894).

Usually light brown or fulvous with fuscous markings.

Length to tip of elytra 5.50–6 mm , ♂ 4.75–5 mm.

Vertex as long as broad, sub-acute, a narrow, unbroken black line on anterior margin, and a transverse brown or fus-

cous band between the eyes with a projecting tooth at center, base and anterior part white or yellowish white. Face white, two black lines on upper part. Pronotum more than twice wider than long, brown with transverse whitish band in front of the middle, often with light median stripe back from this to posterior margin. Elytra cupreous brown with whitish hyaline spots; two to four oblique reflexed veins from outer anteapical cell or tip of discal cell.

Genitalia: ♀, ultimate ventral segment truncate or very slightly produced at center, sometimes barely notched at middle on hind border, black patch covering central part about half way to base; ♂, valve short; plates short, outer margin curved or sub-angular. Widely distributed in United States. Specimens are in hand from Vermont, New York, New Jersey, Pennsylvania, Ohio, Illinois, Iowa, Kansas, Colorado, Michigan, District of Columbia, Alabama, Texas, and California.

This species presents great variability, and many of the variations seem to defy limitation, passing by such insensible grades as to make precise definition impossible. The following forms seem to be fairly well defined, and are characterized as a step toward the designation of limits, which may be possible when food plants and larval characters are known.

Some, indeed, seem so different in size and other characters as to be worthy of specific distinction, but these differences seem to me to be too inconstant to fully warrant other than varietal distinction.

Var. minor, n. var. Length ♀, 5 mm; ♂, 4.25-4.50 mm. Vertex slightly more obtuse than typical *immistus*, face often deeply infuscated. ♀, last ventral segment usually slightly produced, and generally appearing somewhat carinate, due to compression against ovipositor. ♂ plates folded at sides and apparently longer than in typical *immistus*. Ames, Iowa; July and August. Abundant.

Var. major, n. var. Length to tip of elytra, ♀ 7 mm, ♂, 6mm. Vertex with dark fuscous cross band with a liguliform projection at middle, marginal line broad and broken at apex. Face infuscated, especially at sutures. ♀, ultimate ventral segment very slightly produced, pygofers long. ♂ plates broad, scarcely reflexed at sides, sub-angulate at outer mar-

gin, almost truncate at tip, a little more than half the length of pygofers. Ames, Iowa; Urbana, Ill., (McElfresh); West Virginia (Heideman).

This variety, as compared with *minor*, is very different, and it is only as they are compared with typical *immistus* that they can be conceived to have any specific relationship.

Var. incisus n. var. Size of typical *immistus*, but with markings very distinct, and with the last ventral segment of the female distinctly incised at center, and the male plates broad.

SCAPHOIDEUS MELANOTUS n. sp. (Plate X, Fig. 13).

General aspect of *immistus* above, face intensely black, female genital segment strongly produced and notched. Length ♀, to tip of elytra, 5 mm.

Vertex, three fourths as long as wide, anterior margins slightly curved, apex obtuse; front narrow; clypeus long, widening at apex; loræ large, reaching nearly to tip of clypeus, and leaving only a very narrow margin of cheek. Pronotum short, lateral margin short, posterior margin emarginate. Elytra with post-nodal cell very wide behind, two or three very oblique nodal veins, outer claval vein very strong, strongly hooked distally, approximating claval suture, and with the cross vein to suture near base.

Color: Vertex whitish with a rather faint brownish narrow band with darker dot at center, a narrow line parallel to the anterior margin. Face jet black except white point just below apex and on tip of clypeus. Pronotum whitish with large fuscous patch each side, fulvous band broken in front, and fulvous broken band behind. Elytra with marginal lobes on clavus, oblique spots either side of transverse vein, costal and post-nodal cells, white or pale yellowish; claval suture, margin of veins, part of discal anteapical and apical cells, fulvous; base and interlobular spots of clavus, lines on the veins and spots in discal, anteapical, and apical band, dark fuscous or black. Dorsum black with yellow border; below, pectus soiled white with spots on legs, base of abdomen, bands on ventral segments and large spot on last ventral segment, black.

Genitalia: Ultimate ventral segment ♀, long, much produced, notched medially.

Except for very different shape of genital segment this might be considered an extreme melanotic variety of *immistus*, but it is smaller, and the points noted seem so well marked that until intermediate forms are found it must be considered as distinct.

Described from three specimens, all females, two of which are from Texas (U. S. N. M.), and one from Hyattsville, Md., collected by Mr. J. S. Hine, July 9, 1899.

SCAPHOIDEUS OBTUSUS n. sp. (Plate X, Fig. 14).

A broad gray band from pronotum to anteapical cells. Length, ♀, to tip of elytra, 5 mm.

Vertex depressed, obtuse, nearly twice as wide as long, anterior margins curved, minutely carinate; front narrow, sutures converging but slightly till near the tip; clypeus long, slightly enlarging to apex; loræ large, almost reaching tip of clypeus and outer margin of cheek. Pronotum short, lateral margins flaring, posterior margin evenly concave. Elytra, appendix wide; post-nodal cell widening to apex and sharply angular within, post-nodal vein slightly curved and oblique; outer claval vein hooked, remote from suture distally, with distinct cross veins at base to suture and to inner vein.

Color: Head and thorax nearly white or light yellow; vertex cream white with a broad fuscous band between the eyes enlarged at center to form a blunt point before and behind, anterior margin showing a narrow black line; face black, the disk less dense and the frontal arcs not entirely hidden. Pronotum fuscous or black with a milky median cross and posterior border and some fulvous dots on anterior margin; scutellum fuscous with the usual picture in white. Elytra white except lines on the nervures, a basal spot next costa, the anteapical cells and a terminal band, which are fuscous or black. Abdomen below black with white margins. Below, pectus black with white markings, legs white, venter white, black at base and on discs of segments and apex of last ventral segment.

Genitalia: ♀, ultimate ventral segment long, produced in middle, apex rounded. ♂ last ventral segment narrow bordered with black, valve, plates and pygofer broken off.

Described from one ♀ and one ♂ from Ames, Iowa, and two ♀s from Urbana, Ill., collected by Mr. F. M. McElfresh, and kindly sent to me by Mr. E. D. Ball.

This species belongs in the group with melanotus, but is easily separated from that species by the broad gray band and position of the claval vein.

SCAPHOIDEUS CINEROSUS n. sp.

Ashy gray with dark bands or lines on vertex, pronotum and elytra. Resembles obtusus but vertex more acute, and the apical portion of elytra is not fuscous or black. Length, ♀, 4–4.50 mm.

Vertex nearly as long as wide, sub-acute; front tapering uniformly; clypeus widening but slightly at tip; loræ long, reaching margin of cheek. Pronotum longer than the vertex, hind border barely emarginate. Claval veins hooked, outer bent somewhat toward the suture, but not fusing with it, cross veins from suture to outer claval and between the clavals near the base.

Color: Light ashy gray; vertex almost white with a light brown crossband between the eyes, and a fine black line, sometimes obsolete, next the anterior margin; face more or less infuscated, the lower part of cheek usually whitish; clypeus with a whitish disc. Pronotum light gray with dark patches near lateral hind margin and along anterior border, and two light brown spots near the middle of hinder portion. Elytra ashy gray or whitish, veins infuscated, and faint traces of brownish spots on discal, inner anteapical and apical cells.

Genitalia: ♀ last ventral segment longest at middle, rounded slightly carinate on the middle line toward the apex; pygofers long, slender, with a dark spot near the apex, and scattering white bristles on base and disk, and two brushes of black hairs each side near the apex.

Described from specimens collected at Ames, Iowa, by Mr. E. D. Ball, and Urbana, Ill., (F. M. E.)

Explanation of Plates.

Figures 2, 3, 4, of Plate IX, were drawn for the Iowa Experiment Station by Miss Charlotte M. King, and are used here by the kind permission of Prof. H. E. Summers, Entomologist of the Station. All other figures are by the author.

Plate IX.

Fig. 1. *Scaphoideus picturatus* Osb. *a*, imago dorsal view; *b*, face; *c*, elytron; *d*, ♀, *e*, ♂, genitalia, ... p. 193

Fig. 2. *Scaphoideus jucundus* Uh. *a*, imago dorsal view; *b*, face; *c*, vertex and pronotum; *d*, elytron; *e*, ♀, *f*, ♂, genitalia, ... p. 195

Fig 3. *Scaphoideus ochraceus* Osb. *a*, imago dorsal view; *b*, face; *c*, vertex and pronotum; *d*, elytron; *e*, ♀, *f*, ♂, genitalia, ... p. 199

Fig. 4. *Scaphoideus immistus* Say. *a*, dorsal view imago of var. major; *b*, face; *c*, vertex of typical *immistus*; *d*, elytron; *e*, ♀, *f*, ♂, genitalia, ... p. 204

Plate X.

Fig. 1. *Scaphoideus fasciatus* n sp. *a*, vertex and pronotum; *b*, face; *c*, ♂ genitalia, ... p. 190

Fig. 2. *Scaphoideus auronitens* Prov. *a*, elytron; *b*, wing, . . . p. 194

Fig. 3. *Scaphoideus jucundus* Uh. elytron, ... p. 195

Fig. 4. *Scaphoideus consors* Uh. vertex and pronotum; 4 *a*, ♂ genitalia, ... p. 196

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Fig. 8. *Scaphoideus lobatus* Van D. elytron, ... p. 199

Fig 9. *Scaphoideus productus* n sp. vertex and pronotum; *a*, face; *b*, elytron; *c*, ♀ genitalia, ... p. 200

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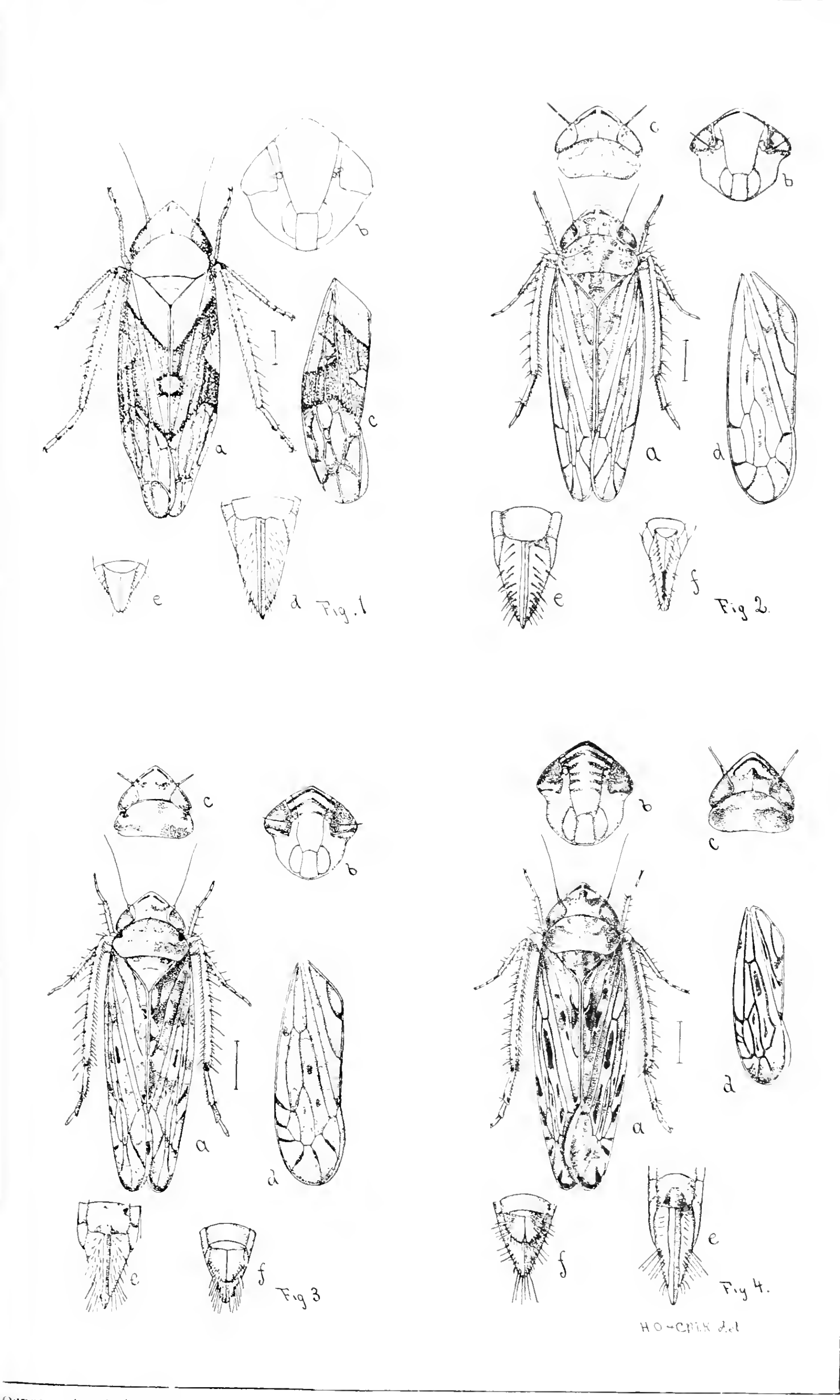
Fig. 1
Fig 2.
Fig 3
Fig 4.

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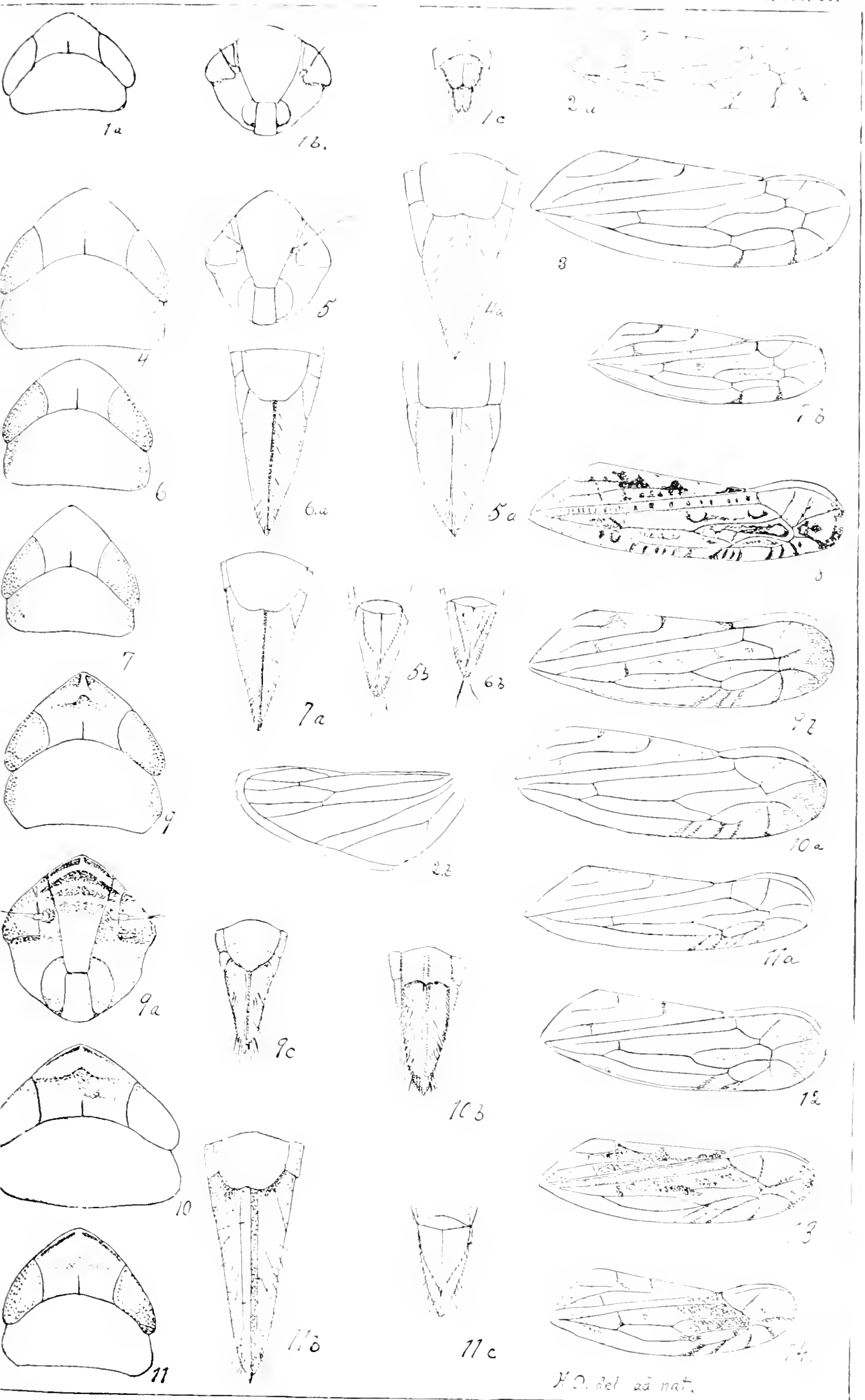
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THE BACTERIAL FLORA OF THE SEMI-DESERT REGION OF NEW MEXICO, WITH ESPECIAL REFERENCE TO THE BACTERIA OF THE AIR.

By John Weinzirl.

The study of the bacterial flora of the semi-desert region of New Mexico was begun about two years ago, the work being undertaken for several reasons.

First, the writer is not aware that any similar attempt has been made in this country, and disregarding occasional experiments, perhaps no similar study has been made anywhere under the same conditions. The results, then, of such a study possess considerable interest from a purely scientific point of view. In the second place, the results may possess some practical bearing, although this point is not especially emphasized. To mention only a single instance of the possible practical bearings, we may cite the practice of promiscuous expectoration of the numerous consumptives who gather in this region. This may be partly due to the general belief that bacteria cannot live at an altitude of 5,000 feet or above.* The utter falsity of this idea is made only too evident by the experiments presently to be recorded.

No attempt will be made to review the mass of literature that has been accumulated on the subject of air bacteria, for such a review would be quite as useless as it would be laborious. Reference to a few of the historic land-marks in the problem may, however, prove of interest.

It is quite certain that the ancient Greeks suspected the existence of organisms in air, causing fermentation and decay, but they possessed no means for their actual demonstration. The Greeks loved speculation more dearly than scientific demonstration, and so this truth, surmised by them, was destined to remain a secret until Antony von Leeuwenhock, a Dutch lense-maker with scientific inclinations, discovered the bacteria in putrid solutions, in the saliva of the mouth,

* The altitude of Albuquerque is approximately 5,000 feet. This, then, would be practically the upper limit of germ life.

and in tartar from the teeth. This was in 1675. New life was given to the tottering theory of spontaneous generation by this discovery, and two more centuries of experimentation were required for its final overthrow. In this experimentation the bacteria of the air played an important part, for when life was extinguished in fermenting solutions by heating them, new life soon entered from the air.

In demonstrating the role played by air bacteria, the classical researches of Pasteur and Tyndall are most interesting. Pasteur had previously shown that nutrient bouillon contained in glass vessels, and stoppered with ordinary cotton-wool, would not ferment after sterilization. To show that the ferment which spoiled the medium in the previous experiments came from the air, he exposed a large number of tubes containing sterile bouillon, by removing the cotton stoppers for a time and then replacing them again. Nearly all the tubes so exposed underwent fermentation while others kept as controls remained sterile. This experiment was performed near Paris. To show that the ferment (bacteria) varied in quantity in different places, he repeated his experiment in the Alps mountains, and found that only a few of the tubes fermented.

We have then in Pasteur's work the first evidence that the air of high altitudes contains relatively fewer bacteria than that of lower altitudes.

Tyndall was primarily interested in the physics of light, and his contributions to biology were merely incidental to physical problems. In order to obtain air free from dust particles, and which should reflect none of the light passing through it, he constructed an air-tight box and covered its inner walls with glycerin. When the box was allowed to stand for some time, the particles of dust settled upon the sides and were held fast by the glycerin. Having become interested in Pasteur's work on air, he was curious to know whether any organic life remained in the air of his box. Sterile nutrient media were exposed in the interior of the box for some time, but they developed no life. Thus he proved in a novel way that air does contain bacteria, and that the putrefaction of the solutions is not due to life arising spontaneously.

From this time on many important contributions were made to the air flora, notably by Petri and others, but we must pass them and review only the more recent researches of Miquel, which are, perhaps, the most extensive that have been carried out, or at least cover a greater period of time, viz, ten years. His monthly examinations of the air of Paris before the city hall, and at the Mont-Souris observatory, located in a park in the suburbs, and which may be regarded as country air, are summarized below. The figures represent the number of bacteria per cubic meter or 1,000 liters of air.

	Mont-Souris.		Paris — City Hall.	
	Bacteria.	Molds.	Bacteria.	Molds.
Winter	170	145	4,305	1,345
Spring	295	195	8,080	2,275
Summer	345	245	9,845	2,500
Autumn	195	230	5,665	2,185
Average	250	205	6,975	2,705

From Miquel's table it is seen that the air in the park contained on the average about one twenty-eighth as many bacteria as the city air — a point of considerable interest. It is also seen that the number is greatest in summer and least in winter, and somewhat less in the autumn than in the spring.

Without further comment on the above at the present time, we will proceed to the experimental part of our work. It was thought that the simple method of exposing petri dishes containing a layer of sterile neutral medium, would give approximate results, and, perhaps, be as practicable as any. Only qualitative data can be obtained in this way, since we have no means of estimating the volume of air in which the bacteria were contained. Later in the work some quantitative determinations were also undertaken. The discussion of the methods and results of the latter will be postponed until after the qualitative work has been recorded.

In general, it may be stated that most of the experiments were performed in the vicinity of the University of New Mexico, which is situated on the "Mesa," an elevated plain, east of the city of Albuquerque. Some exposures have also

been made in different parts of the city itself. A number of exposures have also been obtained in various places in the Territory, and in these instances I have been materially assisted by a number of my students.

The details of the several experiments will now be recorded and discussed in turn.

Qualitative Determinations of Air Bacteria.

Exp. 1.— September 28, 1898, 4.00 P. M. Three agar petri plates were exposed 100 feet from University building, to the air for 2, 4, and 6 minutes respectively.

Conditions: Stiff southwest breeze; dry; no rain for several weeks.

October 3.— Colonies were counted with the following results:

Pl. 2 min.—6 bacteria (3 spp.) and 1 mold.
Pl. 4 min.—40 bacteria (4 spp.) and 2 molds.
Pl. 6 min.—50 bacteria (4 spp.) and 2 molds.
Average per 10 min., 71 bacteria.

The species of bacteria were A_1, A_2, A_3, and A_4.

For descriptions of species, see the end of this paper. The letter "A" was arbitrarily given to all the air bacteria to distinguish them from other cultures in the laboratory. The decided and brilliant colors of these colonies may be of service to the reader in keeping them in mind. They may be summarized as follows:

A_1 — salmon-pink.
A_2— sulphur-yellow.
A_3— milky-white.
A_4— Orange-yellow.
A_5— pink.
Others — some modification of white.

Exp. 2.—October 7, 1898, 4.00 P. M. Three agar plates were exposed to air 200 feet east of University building for 2, 4, and 6 minutes respectively.

Conditions: Gentle breeze blowing; no rain for some weeks; a dozen flies interfered with exposures.

October 12.—Colonies were counted as follows:

Pl. 2 min.—18 bacteria (2 spp.) and 3 molds.
Pl. 4 min.—47 bacteria (4 spp.) and 1 mold.
Pl. 6 min.—61 bacteria (5 spp.) and 0 mold.
Average per 10 min., 102.7 bacteria.

The species were A_1, A_2, A_5, A_8, and A_9.

Exp. 3.—October 13, 1898, 9.30 A. M. Three gelatin plates were exposed 300 feet east of University building for 2, 4, and 6 minutes respectively.

Conditions: Stiff breeze from east, *i. e.*, from the mountains over the "Mesa;" dry.

October 24:

Pl. 2 min.—0 bacteria and 2 molds.
Pl. 4 min.—13 bacteria and 3 molds.
Pl. 6 min.—? bacteria and 8 molds.
Average per 10 min. (Pl. 4 min.) 32 bacteria.

This last plate was covered by molds, so that the colonies could not be counted with any degree of certainty.

The colonies of each species on Pl. 4 min. were counted with the following result:

A_1.—3 colonies: 23.6 per cent.
A_2.—2 colonies: 15.4 per cent.
A_3.—4 colonies: 30.8 per cent.
A_9.—4 colonies: 30.8 per cent.

Exp. 4.—October 17, 1898, 4.00 P. M. Three agar plates were exposed northeast of main building for 2, 4, and 6 minutes respectively.

Conditions: Clear with slight breeze.

October 25:

Pl. 2 min.—3 bacteria (2 spp.) and 3 molds. Spp.: A_1, 2 colonies; A_2, 1 colony.

Pl. 4 min.—44 bacteria (4 spp.) and 1 mold. Spp.: A_1, 22 colonies; A_2, 5 colonies; A_3, 2 colonies; A_9, 15 colonies.

Pl. 6 min.—62 bacteria (4 spp.) and 1 mold. Spp.: A_1, 18 colonies; A_2, 6 colonies; A_3, 3 colonies; A_9, 35 colonies. Average per 10 min., 36.1 bacteria. A_3 is a milky white colony, while A_9 is ashy-grey in color.

October 28.—A colony of red yeast was also found.

Exp. 5.—October 20, 1898. Three plates were exposed 500 feet from main building for 2, 4, and 6 minutes respectively. A moderate breeze was blowing from the west, *i. e.*, from the city toward the University grounds.

October 27:

Pl. 2 min.—(agar), 10 bacteria.
Pl. 4 min.—(gelatin), spoiled.
Pl. 6 min.—(agar), 30 bacteria.
Average per 10 min., 50 bacteria.

Spp.: A_1, A_2, A_3, A_4, and A_9.

Exp. 6.—November 17, 1898, 10.00 A. M. Made three agar plate exposures 15 rods northeast of main building for 4, 6, and 12 minutes. Air was clear, calm, and warm. No rain for some time.

November 22:

Pl. 4 min.— 2 bacteria and 1 mold.
Pl. 6 min.— 5 bacteria and 1 mold.
Pl. 12 min.— 5 bacteria and 1 mold.
Average per 10 min., 5.8 bacteria.

Beside other colonies, A_6 and A_7 were isolated. The great relative falling off in number, even with increased time, is remarkable.

Exp. 7.—November 28, 1898, 10.00 A. M. Made three plate exposures about 500 feet north of buildings.

Conditions: Clear and cold with moderate south breeze. Five inches of snow fell on the 26th and nearly disappeared on the following day.

December 12:

Pl. 5 min.—(agar), 4 bacteria and 1 mold.
Pl. 10 min.—(agar), 26 bacteria and 2 molds.
Pl. 10 min.—(gelatin), 1 bacteria and 0 mold.
Average per 10 min., 11.6 bacteria.

This experiment illustrates the weakness of our method of analysis. The variation in the number of bacteria that fell upon the several plates is most remarkable. This is not wholly a disadvantage, however, for it shows the decided irregularity existing in the number of bacteria that different portions of the air may contain at the same time. This

difference is even greater when different periods of time are taken. Perhaps an average of the three plates taken gives us a figure that is fairly representative.

Exp. 8.— December 7, 1898. Three agar plates were exposed about 30 rods east of buildings for 30 minutes. Air was clear and cold, with slight breeze from the south.

December 12.— No growth. Plates were kept too cold.

December 22:

Pl. 1.— 75 bacteria (6 spp.) and 7 molds.
Pl. 2.— 113 bacteria and 4 molds.
Pl. 3.— 260 bacteria and 10 molds.
Average per 10 min., 49.8 bacteria.

Again note the variations in numbers. A_5 and A_{10} were isolated from above plates.

Exp. 9.— December 20, 1898. Three agar plates were exposed simultaneously as follows:

No. 1.— 15 min. in Biological Laboratory on table.
No. 2.— 15 min. in open air north of building.
No. 3.— 15 min. in private residence near by.

January 1, 1899:

No. 1.— 36 bacteria and 1 mold.
No. 2.— 92 bacteria and 3 molds.
No. 3.— 106 bacteria and 6 molds.
Average per 10 min. (No. 2), 61.3 bacteria.

These results are interesting, since they give us a comparative idea of the number of bacteria found in rooms as compared with open air. More bacteria were expected from the Laboratory.

Exp. 10.— December 31, 1898. Exposed four plates 30 rods east of main building for 30 minutes. Clear and cold with stiff breeze from northwest.

January 13:

No. 1 (glucose gelatin).— Spoiled by large numbers of molds which luxuriate on sugar media.

No. 2 (gelatin).— 15 bacteria and 5 molds. Colors of colonies are not well defined on this medium.

No. 3 (agar).— 57 bacteria and 2 molds.

No. 4 (agar).— 123 bacteria and 9 molds.

Average per 10 min., 21.6 bacteria.

Exp. 11.— February 13, 1899. Four plates were exposed 20 rods north of main building, all for one hour.

Conditions: Partly cloudy with slight breeze from south. Moderately warm after cold wave.

February 25:

No. 1 (agar).— 21 bacteria and 3 molds.
No. 2 (agar).—33 bacteria and 2 molds.
No. 3 (gelatin).— 27 bacteria and 8 molds.
No. 4 (gelatin).— 10 bacteria and 5 molds.
Average per 10 min., 3.8 bacteria.

Exp. 12.— March 28, 1899, 10.20 A. M. Exposed four plates north of University grove for 30 min.

Conditions: Clear; moderate breeze from southwest; slight snow storm on 27th, which makes the ground wet to-day.

April 7:

No. 1 (agar).— 10 bacteria and 4 molds.
No. 2 (agar).— 9 bacteria and 3 molds.
No. 3 (gelatin).— 18 bacteria and 4 molds.
No. 4 (gelatin).— 20 bacteria and 2 molds.
Average per 10 min., 4.75 bacteria.

It might appear from this experiment that the gelatin medium developed more colonies than agar, but this does not hold in other exposures, as in Exp. 11, for example.

Exp. 13.— October 5, 1899, 3.45 P. M. Three agar plates were exposed north of grove for 28, 40, and 60 min. respectively.

Atmosphere was clear and calm.

October 11:

Pl. 28 min.— 51 bacteria (4 spp.) and 6 molds.
Pl. 40 min.— 290 bacteria (5 spp.) and 19 molds.
Pl. 60 min.—Covered with molds. No count made.
Average per 10 min., 49 bacteria.

Spp. present: A_1, A_2, A_3, A_4, A_5.

NOTE.— Plates 20 and 40 minutes were photographed to show the relative numbers of bacteria, as well as the size of colonies, etc. See Figs. I and II, page 219.

Exp. 14.— October 19, 1899, 3.18 P. M. Made three agar plate exposures north of grove.

Atmosphere clear, calm and warm.

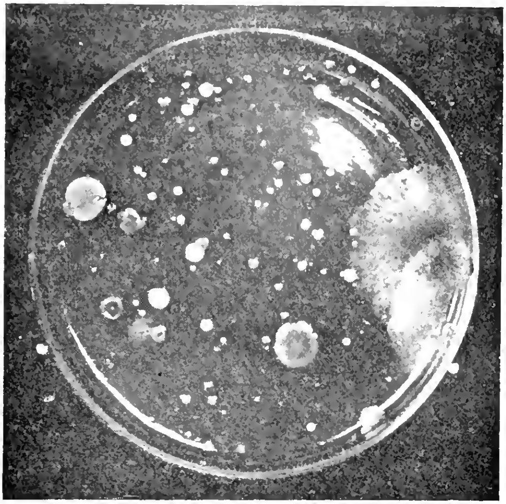


Fig. I.

Petri plate exposed 28 min. to air on "Mesa," near the University.

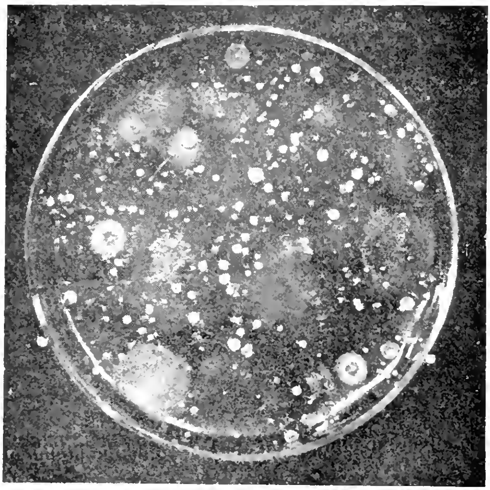


Fig. II.

Petri plate exposed 40 min. Otherwise same as Fig. I. The white spots indicate colonies — the smaller ones being bacteria, and the largest ones molds.

October 27:

Pl. 24 min.—161 bacteria and 8 molds.
Pl. 40 min.—242 bacteria and 19 molds.
Pl. 60 min.—187 bacteria and 24 molds.
Average per 10 min., 52.8 bacteria.
Spp. present: A_1, A_2, A_3, A_4, and A_{12}.

The following three experiments may be included here, though they really constitute a single experiment. Their object is to show the effect of rain in clearing the atmosphere. The first experiment (No. 15) as the data show, was made soon after a considerable rain. The other experiments follow on successive days.

Exp. 15—November 15, 1899, 3.53 P. M. Three agar plates were exposed east of Gymnasium after a heavy rain ($\frac{5}{10}$ in.) which fell at noon to-day. There were slight previous showers also. The ground was thoroughly wet down. Atmosphere, clear. Slight breeze from southeast.

November 28:

Pl. 20 min.— 7 bacteria and 10 molds.
Pl. 40 min.—10 bacteria and 18 molds.
Pl. 60 min.—10 bacteria and 27 molds.
Average per 10 min., 2.5 bacteria.

Three species: A_1, A_2, A_3.

Exp. 16—November 16, 1899, 3.23 P. M. Exposed three agar plates for same time and in same place as in previous experiment. Soil still quite damp. Atmosphere, clear. Quite strong wind from southeast.

November 28:

Pl. 20 min.—51 bacteria and 4 molds.
Pl. 40 min.—Spoiled.
Pl. 60 min.—23 bacteria and 9 molds.
Average per 10 min., 14.65 bacteria.

Exp. 17—November 17, 1899, 3.04 P. M. Agar plates were exposed as before, under following conditions: Very slight dust beginning to appear. Cloudy, with practically no wind.

November 29:

Pl. 20 min.—126 bacteria and 6 molds.

Pl. 40 min.—143 bacteria and 5 molds.

Pl. 60 min.—133 bacteria and 6 molds.

Average per 10 min., 40.3 bacteria.

NOTE.—Large molds on second and third plates undoubtedly prevented the growth of some bacteria.

Since the details of the above experiments are rather numerous to carry in mind, it may be advantageous to cast them into table form. For such a summary the figures have already been reduced to a common basis, that is to a basis of ten minute exposures.

The figures thus obtained for the several plates in a given experiment are averaged for the final figure of the table. The experiment number, date, and number of plates averaged are given, as well as the weather conditions which necessarily are made very brief. The table is as follows:

TABLE I.—*Summary of Plate Exposures.*

Experiment.	DATE.	No. of Pls. Averaged.	Average No. of Bacteria Falling Per 10 Min.	ATMOSPHERIC CONDITIONS, ETC.
1	Sept. 28, 1898	3	71.	Stiff breeze from S. W., no rain for weeks.
2	Oct. 7, '98	3	102.7	Gentle breeze — flies interfered.
3	Oct. 13	1	32.	Stiff breeze from E.
4	Oct. 17	3	36.1	Slight breeze.
5	Oct. 20	2	50.	Moderate breeze from W.
6	Nov. 17	3	5.8	Calm.
7	Nov. 28	3	11.6	Moderate breeze from S.; also 5 in. of snow two days previous.
8	Dec. 7	3	49.8	Slight breeze from S.
9	Dec. 20	1	61.3	....
10	Dec. 31	3	21.6	Stiff breeze from N. W.
11	Feb. 13, 1899	4	3.8	Slight breeze from S.
12	March 28	4	4.75	Slight breeze from S. W.
13	Oct. 5	2	49.	Calm.
14	Oct. 19	3	52.8	Calm.
15	Nov. 15	3	2.5	After heavy rain. Slight breeze from S.W.
16	Nov. 16	2	14.65	Next day after rain. Strong wind from S.W.
17	Nov. 17	3	40.3	One day later. Practically no wind.

We may observe from the above data that the decrease in the number of bacteria in the air in winter, over fall and spring, is quite plain. Experiments 1, 3, 4, 5, 8 and 9 representing autumn conditions, stand in marked contrast to experiments 6, 10 and 11 of the winter season. Yet experiments 8 and 9 show how great a variation even the winter season may present. It is unfortunate that the conditions of the weather were not recorded in experiment 9, but presumably some disturbing factor entered. Two such factors enter prominently to modify our results. Wind, frequently resulting in dust-storms in our locality, increases the bacteria in the air, while rain produces the opposite effect. These two factors may neutralize each other wholly or in part and thus modify the final result. The effect of rain is nicely illustrated by the results obtained in experiments 15, 16 and 17. The first exposure was made shortly after a heavy rain, and similar exposures were made on the two following days. The average number of bacteria that fell on the plate in 10 minutes on the three days was 2.5, 14.65 and 40.3. Here we have a constant and material increase as the ground dried off, or as the effect of the rain factor diminished.

The explanation of the effect produced by rain lies in two directions. First, during the rain the atmosphere is literally washed of impurities, including bacteria. Secondly, the laying of the dust and subsequent soaking of the soil prevents for a period of time the rising of dust and the bacteria contained in it. As the dust increases the bacteria again increase in the air.

Ultimately, rain may exert yet another influence. It is well known that bacteria require considerable moisture for reproduction and multiplication. For this reason they do not increase during their journey through the air, but only in moist soil, in decaying bodies, in stagnant pools, etc. It is evident that rain facilitates reproduction by furnishing one of the most essential factors for it, viz., moisture.

As to the workings of the wind, it is plain that its only effect is to carry dust and its bacteria into the air and to transport them for varying distances. This factor is of greatest importance when dust is most abundant and relatively insignificent after heavy rains.

Still another factor may enter more or less prominently, though indirectly, to modify the number of bacteria to be found in the air; this factor is sunlight. That direct sunlight is a powerful germicide is well known. Its effect then is to decrease the actual number of bacteria that might otherwise find their way into the air. It is not possible to make a reasonably accurate estimate of the force of this factor, but some idea may be obtained from a number of experiments made in testing the effect of direct sunlight on two of the air bacteria—A_2 and A_5. Both of these bacteria are micrococci, and hence do not form spores. A_2 is killed by direct sunlight in about 30 minutes (March 3, 1900, 12.30–1.00 P. M.) and A_5 in 20 to 25 minutes (January 21, 1900, 11.30–11.50 A. M.)

The potato bacillus is not materially killed out in less than 60 minutes and the spores survive a much longer period. It is possible that the air bacteria can survive the effect of sunlight much longer than other forms which might be abundant in the air but for this fact. Professor H. L. Russell, in exposing an agar plate of *B. campestris* (cabbage blight) to sunlight for 30 minutes showed that this organism is completely killed out in that length of time on the sunny portion with heavy growth in the shaded part.* Probably the killing-out time was even less than 30 minutes. Further remarks in this line are reserved for a subsequent paper.

Perhaps further discussion along this line may be postponed with advantage until we have recorded a number of similar experiments made under modified conditions and which were made with special objects in view. Several experiments were made to show the relation between the number of bacteria in the air in the residence and business districts of the city of Albuquerque.

Exp. 18—October 20, 1899, 6.00 P. M. Three agar plates were exposed in private yard on South Arno Street in the residence portion of town for 20, 40, and 60 minutes. No wind.

October 27:

Pl. 20 min.—529 bacteria and 3 molds.
Pl. 40 min.—575 bacteria and 9 molds.
Pl. 60 min.—Worthless, due to molds.
Average per 10 min., 276 bacteria.

* Wis. Agrl. Exp. Sta. Bul. No. 65, p. 19.

At least 6 species were present, viz: A_1, A_2, A_3, A_4, A_6, and A_{111}.

Exp. 19—October 20, 1899, 5.25 P. M. Plates were exposed as in previous experiment but in business portion of town, *i. e.* on sidewalk on Gold Avenue. Time—10, 15 and 30 minutes. No wind.

October 25:

Pl. 10 min.—1,197 bacteria, 13 molds and 1 yeast.
Pl. 15 min.—1,827 bacteria, 15 molds and 5 yeasts.
Pl. 30 min.—2,036 bacteria, 17 molds and 3 yeasts.
Average per 10 min., 1,031 bacteria.

Exp. 20—Jan. 25, 1900, 5.00 P. M. Three agar plate exposures were made in same place as for previous experiment, but for shorter time—1, 3 and 5 minutes. Former plates were too heavily seeded.

February 12:

Pl. 1 min.— 725 bacteria or 7250 per 10 min.
Pl. 3 min.— 976 bacteria or 3253 per 10 min.
Pl. 5 min.—1,228 bacteria or 2456 per 10 min.
Average, 4,320 per 10 min.

Exp. 21—January 26, 1900, 3.00 P. M. Three agar plates were exposed under same conditions as in Exp. 18, *i. e.* in front yard of private residence. Time—20, 40 and 60 minutes.

February 12:

Pl. 20 min.— 980 bacteria or 455 per 10 min.
Pl. 40 min.—1,373 bacteria or 343 per 10 min.
Pl. 60 min.—Spoiled.
Average, 394 per 10 min.

Exp. 22—March 17 and 18. Four agar plates were exposed on Gold Avenue as in Exps. 19 and 20, but the first pair of plates were exposed in the evening at the close of business; the second pair the following morning.

6.00 P. M., Mar. 17 (Saturday)—Pl. *a*—2 min. Pl. *b*—4 min.
8.30 A. M., Mar. 18 (Sunday)—Pl. *c*—2 min. Pl. *d*—4 min.

March 23:

Pl. *a*, 2 min.—150 bacteria and 1 mold.
Pl. *b*, 4 min.—208 bacteria and 0 mold.
Average per 10 min., 685 bacteria.
Pl. *c*, 2 min.—41 bacteria and 1 mold.
Pl. *d*, 4 min.—37 bacteria and 0 mold.
Average per 10 min., 149 bacteria.

NOTE.— Plates *b*—4 minutes, and *d*—4 minutes, were photographed to show the relative proportions between evening and morning conditions. See Figs. III and IV, page 226. Plates were photographed March 28.

Exp. 23—March 17 and 18. Duplicated conditions of last experiment on South Arno Street, *i. e.* residence district. Time—5 and 10 minutes.

March 23:

Pl. *a*, 5 min. (7.33 P. M.)—346 bacteria and 5 molds.
Pl. *b*, 10 min. (7.33 P. M.)—636 bacteria and 8 molds.
Average per 10 min., 664 bacteria.
Pl. *c*, 5 min. (7.33 A. M.)—103 bacteria and 7 molds.
Pl. *d*, 10 min. (7.33 A. M.)—128 bacteria and 8 molds.
Average per 10 min., 167 bacteria.

It will be observed that the six experiments just recorded were planned in pairs—18 and 19, 20 and 21, etc. The object was to establish a comparison of conditions between the residence and business portions of the city of Albuquerque. If the data of Table I are borne in mind, we can also establish a comparison between the country air and that of the two parts of the city.

If then we make the first comparison, that is between the residence and business portions, we find that the latter uniformly shows a higher number of air bacteria, the ratios being (per 10 min.) 276:1,031; 394:4,320, etc.

Probably the second ratio of approximately 1:10 is nearer the actual than the first because of the thickly seeded plates in the former—some of the bacteria being prevented from developing; and partly also because of the difficulties in counting the colonies.

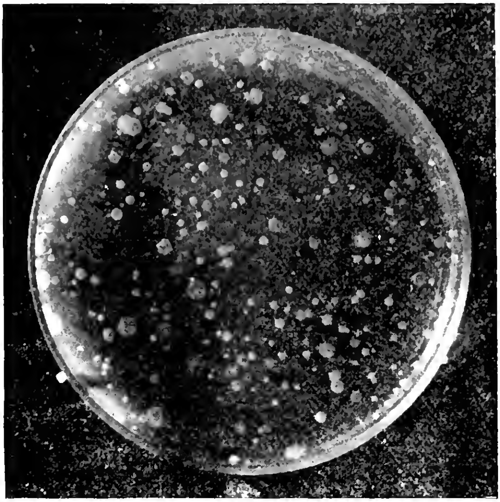


FIG. III.
Plate B, exposed to air for four minutes in business district
of Albuquerque, at 6.00 P. M

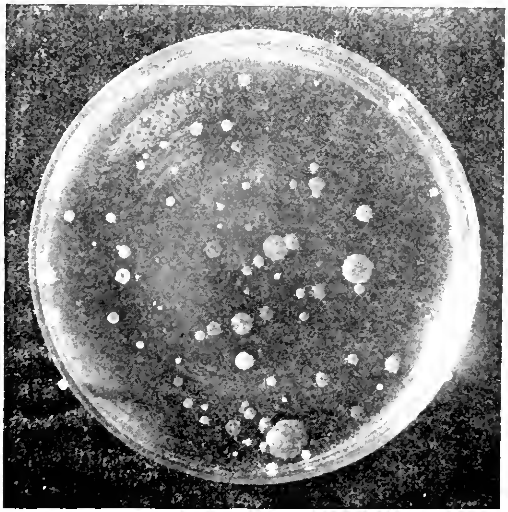


FIG. IV.
Plate D. exposed to air for four minutes in business district
of Albuquerque. at 8.30 A. M.

These figures present a striking illustration of the relative numbers of bacteria contained in the air at the closing and opening of business.

If we take Exp. 14, of October 19, 1899, as representative of "mesa" or country air, we have then as compared with the residence district the following ratios: 52.8:276 and 52.8:394 or approximately 1:6; and for the business district the following: 52.8:1,031 and 52.8:4,320. Assuming the latter to be freer from error, we would have an approximate ratio of 1:80. In other terms, as compared with country air, that of the business district of Albuquerque contains about eighty times as many bacteria. Undoubtedly, at times, the difference is much greater than this even.

Experiments 22 and 23 are intended to show the difference between the relatively undisturbed air in the morning and the same in the evening after the disturbances due to business life in the two sections of the town. For this purpose Saturday evening and Sunday morning were selected as showing perhaps the greatest extremes. In the business district we have the ratio of 685:149 or about 5:1 (see Figs. III and IV); and in the residence district 664:167 or about 4:1. This illustrates well the fact that in large part the heavily-laden air of the city is due to the intense activity of business life.

The flora of the city air in the above was not worked out, as no special interest was involved. It was, as might have been expected, more extensive than that of the country air.

A few experiments were also made to show for the most part the character of the flora of districts lying at some distance from Albuquerque. They are as follows:

Exp. 24—March 19, 1899, P. M. Belen, N. M., 30 miles south of Albuquerque. Three agar plates were exposed in usual way by Rev. T. A. Bendrat, for one hour. No wind.

March 29:

Pl. 1— 96 bacteria and 1 mold.
Pl. 2—126 bacteria and 12 molds.
Pl. 3—178 bacteria and 7 molds.
Average per 10 min., 22 bacteria.

The species were as follows: A_2, A_3, A_4, A_9, and A_{11}. The yellow colonies predominated, while the red colonies invariably found at Albuquerque were absent. A_{11} is new.

Exp. 25—March 30, 1899, 3.30 P. M. Socorro, N. M., 75.5 miles south of Albuquerque. Three agar plates were exposed by Mr. J. B. Terry, in the usual way, about one-half mile west of town. A heavy rain four days previous. Wind very slight.

April 5:

Pl. 30 min.—168 bacteria and 12 molds.
Pl. 45 min.—264 bacteria and 14 molds.
Pl. 60 min.—228 bacteria and 14 molds.
Average per 10 min., 51 bacteria.

Species present: A_1, A_2, A_3, A_4, A_5, and A_9.

This is substantially the same flora as at Albuquerque, but the red colonies were numerous, especially A_5, which at the former place was relatively infrequent. The white colonies predominated.

Exp. 26—April 30, 1899. Belen, N. M. Three agar plates were exposed for 30 minutes by Rev. Bendrat. The exposure was made on the roof of a store-building, height, 15 ft. Very slight breeze.

May 8:

Pl. 1—317 bacteria and 14 molds.
Pl. 2—344 bacteria and 6 molds.
Pl. 3—890 bacteria and 9 molds.
Average per 10 min., 172.3 bacteria.

Species: A_1, A_2, A_3, A_4, and A_5. The flora for this exposure is identical with that for Albuquerque, but the red colonies, A_1, and A_5 are very rare, while A_3 and A_4, predominate.

Exp. 27—May 2, 1899. Clemens' ranch, in San Mateo mountains, 15 miles from Magdalena and 105 miles south of Albuquerque. Altitude nearly 6,500 ft. Two plates were exposed by Prof. F. S. Maltby under the following conditions:

Pl. 1—May 1, 2.25 P. M. Exposed for 30 minutes on watering trough. Considerable wind carrying dust from horse corrals over plate.

Pl. 2—May 2, 6.20 A. M. Exposed for 35 minutes in front of cabin. No wind and no dust.

May 8:

Pl. 1 — 6,042 bacteria.

Pl. 2 — 328 bacteria and 4 molds.

Species: A_1, A_2, A_3, A_4, A_9.

The experiment shows that for this relatively high altitude we still have a considerable number of bacteria. The effect of the various factors incident to an extensive ranch should not be overlooked here. Had the exposure been made some distance out, the results would have been materially different. Nevertheless, we see that bacteria can and do exist here.

Exp. 28—March 8, 1900. Hell Canon, 15 miles east of Albuquerque in Sandia mountains. Three agar plates were exposed by Pres. C. L. Herrick. No wind.

Pl. 1—6.30 - 8.00 P. M.

Pl. 2—6.30 P. M. - 6.00 A. M.

Pl. 3—6.30 P. M. - 6.00 A. M.

March 16—Pls. 2 and 3 show no growth, the medium having been completely dried up, due to the dryness of the atmosphere. The plates had been placed in the moist chamber for development with the hope of saving the work.

Pl. 1—90 min.—167 bacteria and 8 molds.

Average per 10 min., 18.5 bacteria.

Species: A_1, A_2, A_3, A_4, A_9, and A_{10}.

The above experiments (24-28) would indicate that the bacterial flora in other parts considerably removed, is very similar to that about Albuquerque. The greatest difference is found in percentages of the species. A given species that is abundant in one place may be rare in another, while the reverse may be true of other species.

The exposure in Hell Canon shows rather a larger number of bacteria for an uninhabited mountainous district than might have been expected.

Experiments with Reference to Altitude.

In order to make a special test of altitude in this connection, several experiments were made at Camp Whitcomb, which is located in Tijeras canon, 18 miles east of Albuquerque, and at a height of nearly 7,000 ft.

Exp. 29.—July 28, 1900, 9.00 A. M. "Cliffs" near Camp Whitcomb. About 7,000 ft. Three agar plates were exposed on some large rocks in shade for an hour. Light breeze from over the canon. Location is sufficiently removed from the camp so as not to be affected by it.

Aug. 8:

Pl. 1—Completely dried up.
Pl. 2—106 bacteria.
Pl. 3—111 bacteria.
Average per 10 min., 18 bacteria.

The colonies were all white with only two species present.

Exp. 30.—July 30, 1900. Camp Whitcomb. Six agar plates were exposed as follows:

Pl. 1—15 min.
Pl. 2 and 3—30 min.
Pl. 4—60 min.

Time 11.45 A. M.

They were exposed on large rock of the highest peak of the Sandia Mts., altitude about 10,000 ft. A very slight breeze from the west. Slight rain the previous day.

Pl. 5 } 10 min. Time 2.00 P. M.
Pl. 6 }

These two plates were exposed on a lower peak—altitude about 8,500 ft. Double quantities of agar were used to prevent excessive drying out of medium.

Aug. 8—All the plates contain some colonies of bacteria, and a large number of molds which have affected the results detrimentally. Only one plate was counted.

Pl. 2—30 min.—42 bacteria and 15 molds.
Average per 10 min., 14 bacteria.

Three species: A_2, A_{13} and A_{11}, the last two being white and gray in color, respectively.

Exp. 31—Aug. 5, 1900, 5.50 P. M.

Repeated Exp. 29. Plates contained double quantities of agar to balance evaporation.

Exposure was made in open on large rock, there being no sunlight to avoid. No disturbing influences.

Aug. 8—Plates well developed. Early count is necessary.
Pl. 1—Contaminated by melted paraffin.
Pl. 2—42 bacteria and 2 molds.
Pl. 3—58 bacteria and 3 molds.
Average per 10 min., 8.3 bacteria.

This is lower than in previous experiments, probably due to quiet atmosphere and to early counting of plates. The species are A_1, A_2, A_3, A_4, A_{13} and A_{14}. The extent of this flora was somewhat of a surprise to the writer, for only one or two species had been expected. A_{13} and A_{14} were most numerous and both were spore-bearing bacilli.

The three experiments just recorded would seem to leave no room for doubt regarding the fact that bacteria are present not only above 5,000 ft. of altitude, but that they may be found even on the mountain peaks at an elevation of 10,000 ft. at least in the summer season. This fact is in perfect harmony with the general law that wherever vegetation and animals may exist there the bacteria will likewise be found.

Quantitative Data.

In addition to the qualitative work that has been recorded, a number of determinations were also made quantitatively. For this purpose two methods were resorted to. In experiments 33-38, an 18-liter oil can, filled with water, was used as an aspirator to remove the air from a large (500 cc) Erlenmeyer flask. This flask was fitted with a rubber stopper through which entrance and exit tubes passed. These tubes were plugged with cotton, and a quantity of sterile gelatin poured into the flask. The whole apparatus was then sterilized and used after cooling. Connection was made with the aspirator by means of a strong rubber tube. By referring to the table below, it is seen that the results obtained with the flask method are unsatisfactory, for either no bacteria entered or the number was so large as to lead to a suspicion of contamination.

The flask method was, therefore, abandoned for the filter method, which may be regarded as similar to sugar filters used by Miquel, and also by Sedgewick and Tucker. As sugar is difficult to sterilize, and is also liable to adhere to the

walls of the containing vessel, sodium sulphate and finally fine sand were substituted. It was found that the sulphate exerted an inhibitory effect upon the colonies and was, therefore, undesirable. The sand worked admirably, but leads to some trouble in counting the colonies. Still, where the colonies are well developed this difficulty is very slight. The same aspirator was used as before for drawing air through the apparatus.

The filter was made from ordinary glass tubing of approximately ¼-inch bore. This was drawn out at one end so as to lessen the bore to 1-10-inch or so. In the neck thus formed a small, loose, cotton plug was fitted. A layer of carefully sifted sand (40-mesh) was placed upon this cotton, and another cotton plug closed up the mouth of the tube or filter. The whole is thus sterilized by dry heat, preferably in a glass box from which the filter can be removed when wanted. When used the filter is fastened in a clamp and attached to the aspirator. It is desirable, also, that the clamps and other close-lying parts be sterilized; this can be effected in a number of ways: *e. g.*, by washing with sublimate solution. When the aspirator is started the cotton plug is removed. The bacteria enter with the air drawn through the filter, but are held back by the sand. The filter material can be added to any desirable medium.

This method worked quite satisfactorily, and its simplicity and cheapness would seem to recommend it for all ordinary work. If care is taken to insure good suction and a steady current, perhaps the results are as accurate as those obtained with the most elaborate and expensive apparatus.

The number of experiments or determinations made are very limited, but perhaps of sufficient interest to warrant their insertion here. It is thought, however, that a table summarizing the data would be sufficient. Such a table follows:

TABLE II.—GIVING QUANTITATIVE DATA.

Experiment.	Date.	Time.	Place.	Apparatus.	Liters of Air.	No. of Bacteria.	No. of Molds.	No. of Bacteria per Cubic Meter.	Atmospheric Conditions.
33	Feb. 13, 1899	3–4 p. m.	20 rds. N. of Univ.	Flask 1	6	0	....	0	Slight breeze from south. Smoke from burning weeds carried over flask.
				" 2	12	9	....	750	
34	Mar. 2, "	10:15 a. m.	"	" 1	6	0	....	0	Strong wind from city, i.e. W.
				" 2	6	0	....	0	
35	Mar. 18, "	10.00 a. m.	North of Univ.	" 1	10	0	....	0	Strong wind from West.
36	Oct. 19, "	3.10 p. m.	"	" 1	18	9	9	500	Calm and quiet.
37	Oct. 20, "	3.30 p. m.	"	" 1	18	9	8	500	No wind.
38	Nov. 7, "	3.00 p. m.	"	" 1	36	0	....	....	Slight breeze.
				" 2	36	9	2	250	
39	Nov. 28, "	4.00 p. m.	"	Na_2SO_4 filter No. 1	16	2	1	125	No wind.
40	Nov. 29, "	9:40 a. m.	"	" " No. 1	18	0	....	0	Slight breeze.
		3.00 p. m.		" " No. 2	36	1	1	28	Slight breeze.
41	Dec. 10, "	11.30 a. m.	S. Arno St., priv. y'd	" " No. 1	36	2	1	55	Slight breeze.
		1.00 p. m.	" "	Flask No. 1	36	2	0	55	Slight breeze.
42	Dec. 27, "	3.00 p. m.	"	Sand filter	36	12	6	333	No wind.
43	Dec. 30, "	12.00 m.	"	Sand filter	36	4	4	111	No wind.
				Na_2SO_4 filter	36	4	2	111	
44	Jan. 1, 1900	....	"	Sand filter	36	6	5	167	No wind.
45	Jan. 14, "	10.45	"	Sand filter No. 1	54	4	3	75	No wind.
		12.20	"	" " No. 2	54	1	1	18	
46	Jan. 20, "	....	"	" " No. 1	54	7	2	130	Slight breeze.
				" " No. 2	36	2	3	55	
47	Jan. 21, "	....	"	" " No. 1	54	25	1	463	Calm.
48	Apr. 24, "	4.00 p. m.	At Univ.		18	0	1	0	Quite windy.
49	Apr. 25, "	3.30 p. m.	"		36	2	1	55	Slightly windy.

TABLE II.

From the above it is seen that in all, seventeen experiments were made, with a total of twenty-five determinations. These extend from October to April, a period of seven months. The determinations were made partly at the University and partly at the residence portion of Albuquerque (S. Arno St.) Those made at the former place were made for the most part by the flask method, and as the results are somewhat doubtful, they will be eliminated from the following discussion. This leaves only experiments 39, 40, 48, and 49 (five determinations) made at the University. These five give an average of only 41.6 bacteria per cubic meter of air. Taking the eleven determinations made by the same method in the residence district of Albuquerque, we have an average of 143 bacteria per cubic meter, or more than three times the number found in the mesa air. It is recognized that these figures are very imperfect, due to the limited number of experiments made, but they may serve, in a measure, to indicate the conditions as compared with other places. If we take for comparison Miquel's table p. 213, we find that for autumn, winter, and spring we have an average of 6,016 bacteria per cubic meter for Paris and 220 for Mont-Souris. That is, the air of the residence portion of Albuquerque contains rather more than half the number found in Mont-Souris park, while the mesa air contains less than a fifth of that number.

While the number of bacteria per volume are undoubtedly less in our arid district than for similar places in more humid climates, the number found is still quite large; larger, in fact, than had been expected. The explanation of this fact is found in the greater facilities afforded by our climate in transporting into the air such organisms as may be able to thrive. The pulverization of the ground and the creation of dust that is readily carried into the air by our relatively high winds, undoubtedly accounts largely for the condition. In other words, while as many bacteria may not exist in a dry climate as in a moist one, the opportunities for carrying them into the air are relatively much greater, and consequently we find the atmosphere, not free, but well laden with bacterial life.

And here, perhaps, a practical application may be made to the conditions found in our locality. While the intense sun-

light and dryness may do much to kill off bacterial life in New Mexico, we also have greater facilities for distributing what life remains than do most communities. There is, then, abundant room for the application of practical and hygienic sanitation here as elsewhere. Especially is such sanitation desirable in the matter of expectoration by tuberculous patients, more particularly in cities and towns. The rapidity with which sputa may dry and become pulverized, and finally carried into the air as dust by winds, is remarkable. They may be, and undoubtedly are, carried off by our strong winds into the sparsely settled country, but this cannot entirely eliminate the danger.

From a botanical point of view, our flora is quite interesting. A large number of species show highly colored colonies. Six out of the fourteen species are chromogenic. Four of these chromogens are micrococci, viz.: A_1 (salmon pink), A_5 (pink), A_2 (sulphur yellow), and A_4 (orange). Two are bacilli, A_6 (yellow) and A_{10} (pale yellow). The remaining colonies are white or gray-white, and with the exception of A_8, all are bacilli.

Among the micrococci the majority form tetrads, though A_5 is a sarcina and A_8 a diplococcus. The bacilli are usually immotile and sporeless. Bacilli A_{13} and A_{14} form spores.

In numbers the chromogenic and non-chromogenic bacteria are about equally divided. Bacillus A_3 is probably most numerous, with A_2 (yellow coccus) a close second. Of the two red species, A_1 was quite numerous, while A_5 was somewhat rare though usually present. A_4 was not at all abundant except at Belen, but was frequently present. A_9 was frequently present and quite plentiful. All other species were occasional and rare.

It is quite remarkable that this flora is apparently quite constant for our region, as is shown by determinations made fully 100 mi. apart. Even the mountain flora, as shown by experiments in Hell Canon and on the Sandia Mountains, contains most of the common species. It would seem that this general uniformity is to be attributed to the strong winds prevailing here, carrying the bacteria for many miles, thus producing a common flora.

As to the source of these organisms, nothing is positively known. Analysis of superficial layers of the soil show their presence, but this might be attributed to their falling upon the ground. At a depth of several inches we find an entirely different flora, which comprises mostly non-chromogenic, spore-bearing, liquefying bacilli. These have never been worked out in detail. The waters from the Rio Grande do not contain our air flora to any material extent. Analysis of milk from a number of dairymen show different results. At times they are quite absent, and this is especially true of the more careful and cleanly dairies. At other times they form a large proportion of the milk flora. In these instances it is believed, however, that they invariably gain entrance from the air through carelessness on the part of the dairyman. It would appear most probable then that our flora is obtained from the superficial soil layers, especially in moist places.

It has been mentioned that many of the air bacteria may be isolated from milk. It may not be inappropriate to record here, the fact that the typical milk flora, as found elsewhere, is also characteristic here. *B. acidi lactici* (Hüppe) and *B. lactis acidi* (Marpman) have been found in all samples analyzed, and coming from a number of dairymen who deliver milk in the city of Albuquerque.

It may also be mentioned that search has been made for *B. tetanus* in garden and other earth, through animal inoculation, but it has not as yet been found.

Search has been made for *B. subtilis* on native hay, but repeated cultures in bouillon have failed to reveal it. *B. mesentericus vulgatus* can be regularly obtained from native-grown potatoes.

Descriptions of Air Bacteria.

Of the fourteen organisms isolated, nearly all were present on the plates a number of times. These have been quite fully described during the work; the characteristics being corroborated by one or more subsequent cultures. It has been thought worth while to include ten of these descriptions in this place. They are as follows:

A_1.

Morphology.—Medium sized micrococcus; single and in pairs; involution forms are found in old potato cultures; size, about 1 μ.

Gelatin Plate.—Small colony with regular and clear-cut outline; finely granular. No liquefaction. Surface colonies larger than the deep seated ones. Color, salmon-pink.

Gelatin Stab.—Good growth along needle-track, but more abundant toward the surface. A salmon-pink surface growth appears, which spreads with age. No liquefaction. Oxygen is necessary to color production.

Glucose Gelatin.—Apparently no growth. No gas.

Gelatin Slant.—Moderate growth which increases slowly with age. Salmon-pink in color. Smooth, regular and shiny. No liquefaction.

Agar Slant.—Abundant growth, slightly irregular, moist, smooth and shiny. Salmon-pink. Increases with age, the edges becoming paler in color.

Bouillon.—Uniform cloudiness. Quite a heavy pink precipitate gathers at the bottom.

Glucose Bouillon.—No gas and no visible change in medium.

Milk.—Shows a pink surface growth (slight) and also a pink precipitate. No further change during month.

Potato.—Exceedingly slight growth after two days; dries up without further increase. Characteristic salmon-pink color. If kept in moist chamber, the growth proceeds slowly, but becomes abundant and granular and shows the typical salmon-pink color. The potato is slightly darkened.

A_2.

Morphology.—A medium-sized coccus; single, pairs and fours; size, 1 to 1.2 μ.

Gelatin Plate.—Colony begins as a small, round, smooth pin-head growth which increases slowly in size. Color, sulphur-yellow. No liquefaction.

Gelatin Stab.—Moderately abundant growth about equal along entire track. After some days a slight surface growth appears, which ultimately becomes quite abundant and shows the characteristic sulphur-yellow color. No liquefaction.

Glucose Gelatin.—Growth throughout tube but more abundant at surface. No gas.

Gelatin Slant.—Rather slight growth at first, which increases slowly. Quite irregular and shiny, but becomes wrinkled with age. No liquefaction. Sulphur-yellow.

Agar Slant.—Quite abundant sulphur-yellow growth. Regular, moist and shiny. Spreads slowly.

Bouillon.—Uniform cloudiness throughout medium. No surface growth. Yellowish precipitate.

Glucose Bouillon.—No gas. Uniform cloudiness. Precipitate.

Milk.—No apparent change. Sulphur-yellow growth on sides of tube at the surface.

Potato.—Slight sulphur-yellow growth which does not increase and soon dries up. If kept in moist chamber, abundant growth takes place producing moist, shiny, raised ridges. Potato is not changed.

A_3.

Morphology.—Small oval bacillus. Non-motile. Single, but may form short irregular chains. Tendency to involution forms in old potato cultures. Stains readily. Size, .75 μ wide and 1.5 μ long. Rounded ends.

Gelatin Plate.—A small, round, irregular and white colony, which increases considerably in size with age. After some time very slight liquefaction of the medium.

Gelatin Stab.—Abundant growth along track. Most abundant toward surface. Grey color. After ten days a slight pit forms which increases slowly.

Glucose Gelatin.—Slight growth. No gas production.

Gelatin Slant.—At first slight growth, but this becomes quite abundant with time. White, slightly irregular and shiny. Slight liquefaction after ten days.

Agar Slant.—Very abundant, white, spreading, moist and shiny growth. Opaque.

Bouillon.—Heavy and uniform cloudiness. Abundant white precipitate.

Glucose Bouillon.—No gas.

Milk.—No change at either room temperature or blood heat.

Potato.—Abundant growth with age. Irregular outline, surface irregular and warty. White, with creamy tint.

A_4.

Morphology.—Rather large coccus. Single and pairs; occasionally found in short chains. Stains readily. Size, 1.2 μ.

Gelatin Stab.—Abundant growth, but this decreases downward. After several days a small pit appears at the surface, which increases slowly. The surface growth is orange colored.

Glucose Gelatin.—Growth doubtful. No gas.

Gelatin Slant.—At first a slight growth, which increases slowly and becomes moderately abundant. Very irregular and granular. Orange color. Slight liquefaction after seven to ten days.

Agar Slant.—Growth slight but increases slowly. Quite restricted, dry and granular. Orange colored.

Bouillon.—Slight cloudiness with small flocculi present. Orange colored precipitate at bottom.

Glucose Bouillon.—Cloudiness in open arm. Precipitate. No gas.

Milk.—No change.

Potato.—Very slight growth. Orange color. No further change.

A_5.

Morphology.—A medium-sized micrococcus. Sarcina, the packets becoming large. Stains readily. Size, 1 μ.

Gelatin Plate.—Surface colonies larger than deep-seated ones. Bright pink and about the size of a small pin-head. Under the microscope the deep colonies are irregular, strongly lobed and granular. Color, pink.

Gelatin Stab.—Abundant growth along stab, decreasing downward. The slight surface growth increases with age and becomes dark pink or nearly red. No liquefaction.

Glucose Gelatin.—Apparently no growth. No gas.

Gelatin Slant.—Growth slight at first, but becomes quite abundant at the end of a week. The outline is quite irregular and the surface rough. Not shiny. No liquefaction. Color, pink.

Agar Slant.— Slight at first, but increases with age. Very irregular in outline and granular. Smooth and shiny, but shows granular heaped up patches in places. Pink.

Bouillon.— Medium remains quite clear, but flocculi appear after several days. These finally settle to the bottom, forming a pink precipitate.

Glucose Bouillon.— No gas. Moderate cloudiness in open arm. No surface growth. Pink precipitate at bottom.

Milk.— No change during whole month.

Potato.— Exceedingly slight pink growth. This soon dries up. If kept in moist chamber, an abundant growth takes place, which shows granular structure and has a light red color.

A_6.

Morphology.— Small bacillus. Actively motile, with darting movement. Varies somewhat in size. Ends rounded. Single. Spores doubtful. Length, 2.2 μ. Width, 1 μ.

Gelatin Stab.— No liquefaction. Growth moderate and decreases rapidly downward. Surface growth increases slowly, and finally becomes dry and wrinkled. Yellow.

Glucose Gelatin.— Media clear. No gas.

Gelatin Slant.— Slight growth, which becomes abundant in time. Smooth and shiny. Edges minutely dentate. Yellow.

Agar Slant.— Growth becomes quite abundant in time. Forms a thin, dry sheet. Yellow, *i. e.*, darker than sulphur.

Bouillon.— Cloudy and flocculent. Finally heavy yellow precipitate.

Milk.— No change.

Potato.— Growth becomes abundant and spreading. Dark yellow color. Potato turns blue.

A_7.

Morphology.— Bacillus; plump with rounded ends. Single and pairs with short chains in old cultures. Chains are frequently branched. Motile (?). Stains readily. Length, 3.5 μ; width, 1.5 μ.

Gelatin Stab.— Slight growth along needle track, which remains nearly transparent, and becomes granular with age. Also slight surface growth which increases slowly. White. No liquefaction.

Glucose Gelatin.— Media remains clear. No gas.

Agar Slant.— Slight white growth, irregular, dry, and granular. Restricted.

Bouillon.— Uniform cloudiness. Heavy white precipitate.

Milk.— No change.

Potato.— Exceedingly slight white growth.

A_8.

Morphology.—A diplococcus. Medium size. Stains readily. Size, .9–1 μ.

Gelatin Stab.—Growth becomes quite abundant, but remains nearly transparent. White. Considerable surface growth. No liquefaction.

Gelatin Slant.— Quite abundant white growth with regular outline. Smooth, shiny surface. No liquefaction.

Agar Slant.—Abundant white regular growth. Moist, flat, shiny. Wrinkling along median iine with age.

Milk.— No change.

Potato.—Abundant growth of an ashy-grey color. Moist, shiny, spreading. Later forms mounds. Turns potato blue.

A_9.

Morphology.— A large bacillus, resembling the potato bacillus. Single, but usually in chains, which are long and somewhat irregular at times. Ends rounded, but in chains appear square. No spores observed. Immotile. Length, 52. μ; width, 1 μ.

Gelatin Stab.—Abundant growth, decreasing slowly downward. Regular and abundant surface growth. After five days liquefaction takes place, producing a pit which takes in the whole upper portion of the tube. A heavy precipitate falls to the bottom of the liquefied gelatin.

Glucose Gelatin.— Medium remains clear. No gas.

Gelatin Slant.—Abundant white granular growth. Slow liquefaction with the growth sinking into the liquid.

Agar Slant.—Abundant ashy-grey growth. Moist, shiny, and tendency to wrinkle.

Bouillon.— Medium remains quite clear, but a very heavy white precipitate settles to the bottom.

Milk.— Slowly digests the casein without first precipitating the same.

Potato.—Growth slow, but finally becomes quite abundant, producing dome-shaped heaps or mounds of a cream-buff color.

A_{10}.

Morphology.— Medium sized micrococcus. Single, twos, and fours. Stains readily. Size about 1 μ.

Gelatin Stab.—Abundant growth, decreasing downward. Abundant yellowish surface growth. No liquefaction.

Glucose Gelatin.— Slight growth. No gas.

Gelatin Slant.— Growth finally becomes quite abundant. White, with yellowish tinge. Shiny and slightly irregular. No liquefaction.

Agar Slant.—Abundant growth, cream-colored, but turns yellow in time. Moist, spreading, shiny.

Bouillon.— Slight cloudiness with considerable precipitate.

Milk.— Casein is digested without previous precipitation, after two weeks.

Potato.—At first slight growth, but this increases slowly. Dry and wrinkled. Color changes from pale yellow to a decided yellow.

Conclusions.

1. The air bacteria of our semi-desert region presents a somewhat limited flora; but this is found to be widely distributed, due undoubtedly to the high winds which sweep uninterruptedly over our wide stretches of nearly barren mesas.

2. The actual number of bacteria contained in the air is not as large as in fertile and cultivated regions, but the number is not as small as is popularly supposed.

3. It would seem to follow from the above that sanitary measures and precautions should receive practically the same attention here as elsewhere. Disease-bearing materials, such as infected clothes, sputum, etc., should be carefully disinfected or burned.

4. Many of the species show highly-colored colonies; these belong mostly to the group of micrococci. The flora is characterized by its inertness toward sugar media, and its failing to peptonize gelatin.

5. Apparently none of the species have been previously described.

ARTICLE XXII.—A NEW CALANDRID FROM CINCINNATI, OHIO.

BY CHARLES DURY.

(Read March 5, 1901.)

TYPHLOGLYMMA, n. Gen.

(*Typhlos* — blind, *glymma* — engraved figure.)

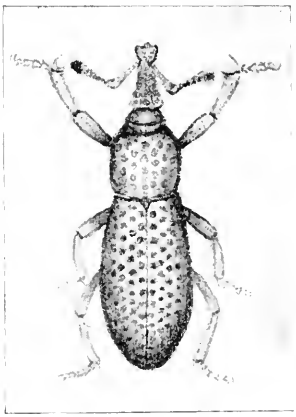
Eyes wanting. Body stout, round, slightly depressed. Beak thick, curved, three-quarters as long as thorax, constricted at base; scrobes deep, beginning at the apical fourth, gradually becoming inferior, where they end close together, separated by a sharp thin carina. Antennal scape not attaining constriction at the base of rostrum.

Funicle composed of seven joints, the first longest, the others subequal and gradually wider. Club round and pubescent. Prothorax squarely truncate at base and nearly so at apex. Elytra elongate, oval, conjointly rounded at tip. Scutellum very minute. Prosternum sharply pointed behind, emarginate in front. Anterior coxæ closely contiguous; the middle ones moderately so, and the posterior very widely separated. Ventral segments consisting of a long basal one without a trace of suture; two very narrow elevated ones, and a rather long terminal one, rounded at tip. Pygidium completely concealed. Femora stout, slightly curved, the anterior ones a little flattened in front, and very shining. Tibia robust and terminating in a sharp stout incurved spur and a smaller blunt one on the inner angle. Tarsi four-jointed; claws small and simple. In general shape, proportion, and appearance resembles *Dryotribus mimeticus* Horn, only much larger.

Typhloglymma puteolatum n. sp. Color dark brown, shining. Head globular, lighter brown than body, glabrous, translucent. Prothorax a little longer than wide, sides subparallel, slightly rounded at basal angles, and also rounded to the broad, feeble apical constriction. Disk covered with large round shallow foveæ. Elytra with rows of very large

shallow foveate punctures. The interspaces very shining, slightly elevated, and with rows of erect yellow bristles. Body beneath coarsely foveate. Rostrum coarsely punctured. Total length .16 inch=4 mm.

One specimen. Batavia Junction, near Cincinnati, Ohio, July 31, 1900. I found this curious little insect while sifting some debris taken from a cavity at the roots of a large oak tree. A spring of cold water flowed out, and the honey-combed center of the tree was occupied by a nest of ants (*Formica pennsylvanica*), so I suspect that the species is myrmecophilous. A careful search has so far failed to reveal other specimens.



2

INDEX.

[An asterisk (*) after the number of a page indicates that a figure of the species is given, or referred to, on that page.]

JOURNAL

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1901—1906.

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VOLUME XX.

ADDITIONS AND CORRECTIONS.

Page 4, add: *Clivina analis* Putz.
" 7, " *Dicælus ambiguus* Laf.
" 11, " (HYDROPHILIDÆ) *Hydræna pennsylvanica* Kies.
" 13, " *Ptomaphagus oblitus* Lec.
" 18, leave out: Microcyptus testaceus.
" 19, add: *Oxyporus quinquemaculatus* Lec.
" 19, " *Lispinus exiguus* Er.
" 20, for Photinus read: *Protinus.*
" 20, add: (TRICHOPTERYGIDÆ) *Limulodes paradoxus* Matth.
" 21, " (PHALACRIDÆ) *Phalacrus politus* Melsh.
" 22, line 2, for noveninotata read: *novemnotata.*
" 22, line 12, for bivulneratus read: *bivulnerus.*
" 22, add: (ENDOMYCHIDÆ) *Mycetæa hirta* Marsh.
" 23, line 18, for bivittatus Gerst, read: *biguttatus* Say.
" 26, add: *Ino reclusa* Lec.
" 27, " *Dermestes caninus* Germ.
" 27, " *Byturus unicolor* Say.
" 28, " *Cryptorhopalum triste* Lec.
" 29, " *Saprinus lugens* Er.
" 29, for AULETES read ÆLETES, and add: *Æ. politus* Lec.
" 30, add: *Brachypterus urticæ* Fab.
" 31, " (TROGOSITIDÆ) *Lycoptus villosus* Csy.
" 32, " *Limnichus punctatus* Lec.
" 33, " (PARNIDÆ) *Psephenus lecontei* Lec.
Lutrochus luteus Lec.
Dryops lithophilus Germ.
D. fastigiatus Say.
Stenelmis linearis Zimm.
S. bicarinatus Lec.
S. crenatus Say.

Page 36, add: *Elater sayi* Lec.
" 39, " *Actenodes mendax* Horn.
" 41, under *Pyractomena*, retain *P. angulata* and *lucifera*, and insert the genus *PHOTINUS*, comprising the species, *pyralis*, *marginellus*, and *scintillans*.
" 41, add: *Tytthonyx erythrocephalus* Fab.
" 45, " (PTINIDÆ) *Lasioderma serricorne* Fab.
" 45, leave out: Sinoxylon sextuberculatum.
" 46, for Sphindus denticollis, read: *Odontosphindus denticollis* Lec.
" 46, add: *Sphindus americanus* Lec.
" 46, " (LUCANIDÆ) *Ceruchus piceus* Web.
" 49, " *Aphodius vittatus* Say.
" 50, " *Cyclocephala immaculata* Oliv.
" 57, line 2, for submarginatus, read: *subarmatus*.
" 57, add: *Saperda candida* Fab.
" 58, " *Orsodacna atra* Ahr.
" 61, " *Diphaulaca bicolorata* Horn.
" 61, " *Haltica bimarginata* Say.
" 62, " *Chætocnema minutum** Melsh.
" 62, leave out: Longitarsus solidaginis Horn.
" 65, after description of Hypophlœus rugosus, add:

Prof. E. A. Schwarz, of the U. S. National Museum, suggests that this may be a form of *Lyphia ficicola* Mulsant, which has been taken at Washington, D. C., where it is said to have been introduced. My specimens occurred in numbers under the bark of old logs, in thick woods, several years in succession, and were evidently breeding, as they were in couples. L. ficicola is said to live in figs.

" 75, for AMNESIA, read: ANAMETIS.
" 79, last line, for angusta, read: *angustula*.
" 81, *Dryotribus mimeticus* is a maritime species. The specimen said to have been found here, may have been accidentally brought in with white sand from the Gulf coast.

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* In this, as in many other instances in the present paper the termination of the specific name has been changed so as to conform to the grammatical gender of the generic name, even though contrary to established usage. For these changes the *Editor* of the Journal is alone responsible. J. L.

OBSERVATIONS ON THE EFFERENT NEURONES IN THE ELECTRIC LOBES OF TORPEDO OCCIDENTALIS.

BY SHINKISHI HATAI,
(From the Biological Laboratory of the University of Cincinnati.)

CONTENTS.

I. MATERIALS USED AND TECHNIQUE EMPLOYED IN THE PRESENT INVESTIGATION.

For the present investigation, the efferent neurones in the electric lobes of *Torpedo occidentalis*, and the spinal ganglion cells from the mid-cervical ganglia of the adult white rat were used. The body weight of the rat was 141 grams. The torpedo material, which was generously furnished by Dr. Ayers, had been preserved with 10% formaline. To prepare this, a thin piece was cut from the lobe and transferred to distilled water for about six hours in order to remove all the formaline. After thorough washing with water, the material was transferred to 35% alcohol, where it remained about one hour, and then it was carried through graded alcohols and imbedded in paraffine in the usual way. The sections were cut 12 μ in thickness. For staining, a saturated aqueous solution of toluidin blue, and for contrast staining, an alcohol solution of erythrosin, were used.

The spinal ganglion of the white rat was preserved with the author's own mixture (formaline-acetic sublimate mixture) (*), and for staining, the reagents just mentioned were used.

II. Finer structure of the efferent neurones of the electric lobes in Torpedo occidentalis.

The efferent neurones of the electric lobes of *Torpedo occidentalis* are so large, more than 0.1 mm. in diameter, that they can easily be seen with the naked eye. Under moderate magnification, the cell bodies show numerous dendritic processes and the single axone is also visible in most cases.

The general form of the cell body is somewhat similar to that of the motor cells in the ventral horn of the spinal cord in man and the higher mammals. In most cases, the nucleus lies on the side of the cell-body towards the axis-cylinder process. The nucleus is nearly spherical, and very large in size proportionately to the cell-body (40–30 μ). The arrangement of the chromosomes in the nucleus is somewhat peculiar. They do not show minute spherules suspended in the delicate meshwork of the linin substance, but instead of that, irregular large masses which fill up meshes of the linin.

The nucleolus is always visible and lies at one pole of the nucleus. Curiously enough, the nucleolus, as a rule, lies in the same relative position in all the cells of a given section.

Under the higher magnification, the internal structure of the cell-body shows a fibrillar arrangement of the cytoplasm. The nature of this fibrillar structure will be discussed later on. In this chapter, only the general arrangements of these fibrils will be described.

Briefly speaking, the cell-body, except the nucleus presents everywhere a fibrillar arrangement of the cytoplasm. The following descriptions apply to the serial sections of one cell (102 μ in diameter, and 60 μ in thickness), and give a general idea of the structure above mentioned.

Hatai, S.—Finer structure of the spinal ganglion cells in the white rat.—Jour. of Comp. Neurology, Vol. XI, No. 1, 1901.

Fig. 1 is a section passing through the periphery of the cell-body. In this figure, the dendritic processes are shown, but not the neuraxone. The position where the neuraxone will arise in the sections is marked by *A*. The fibrillar bundles which come from all dendritic processes of one side of the cell-body (*a*) take a curving course toward the axone hillock, thus forming an arrangement like an inverted U. Other fibrillar bundles come also from the dendrites on the other side (*b*) and take the same course toward the neuraxone. The dotted areas are interpreted as the cross-sections of the similar fibrillar bundles which, running through the cell-body in different directions, are therefore cut at different angles. In this figure, the fibrillar bundles connecting the dendrites with each other are shown very poorly.

Fig. 2 is the section nearer the center of the cell-body and follows Fig. 1. In this figure, the four dendrites are shown clearly, and the localities of the neuraxone is indicated by "*A*," although it does not appear at this level. The fibrillar bundles which form the neuraxone come from each of the dendrites. The dendrites themselves have close relations with each other by means of the connecting fibrillar bundles passing between them. The nucleus is surrounded by the fibrils coming from one of the dendrites (*c*). The fibrillar bundles which come from the dendrites (*d*) also take a part in investing the nucleus. The cross-sections of the fibrillar bundles show as clearly separated groups.

Fig. 3 is a section passing through the middle of the nucleus and follows Fig. 2. In this figure, the nucleolus is visible. The fibrillar arrangements are slightly different from those in the figures already given. In this section the fibrils do not form large bundles, but are divided into smaller strands and interwoven. The intimate connections between the dendrites are clearly shown. The nucleus is also surrounded by the bundles of the fibrils, which come from some of the dendrites. As a rule, in this level the fibrillar bundles near the nucleus are short, because bundles are, for the most part, cut more or less at right angles to their long axis. This suggests that the fibrillar bundles converge towards the nucleus. The peculiar arrangement of the fibrils near the

nucleus has been described as "vortex" or "spiral," or sometimes "Gitterähnliche Anordnung." On the contrary, the fibrillar bundles at the periphery present comparatively long sections. In this section, the neuraxone is not yet shown.

Fig. 4 is a section of the cell-body at another level. In this figure, three dendrites, nucleus, and neuraxone are clearly shown. The neuraxone "*A*" lies at one corner of the base of the rectangular cell-body. An intimate connection of each dendrite with that of the other, and also of all the dendrites with neuraxone is clearly shown in this figure. A curious arrangement of the fibrils is noticeable very near the axone hillock, where the fibrillar bundles have a beautiful spiral arrangement. This spiral arrangement is produced by the fibrils coming from various dendrites as is shown in the illustration. In this figure, connecting fibrils between the dendrites (*a*) and (*c*) are shown very clearly.

Fig. 5 is a section passing through the periphery of the side opposite to that shown in Fig. 1. In this figure, four dendritic processes are plainly shown — one from each corner of a somewhat rectangular-shaped cell-body. The position from where the neuraxone will arise in other section is marked by "*A*." A clear oblong space near the center of the cell-body is the place where the nucleus lies in the other sections. The fibrillar bundles which come from the dendrite (*a*) run towards the dendrites (*c*, *d*) along the one side of the nucleus, and finally enter the dendrites (*c*, *d*). Along the course, a few small fibrillar bundles diverge towards the periphery of the cell-body. The fibrillar bundles which come from the dendrites (*b*) run toward the dendrites (*c*, *d*) in a somewhat similar manner to those from the dendrite (*a*). In this case, the fibrillar bundles divide into two branches at the nucleus and after encircling the nucleus, they enter in the dendrites (*c*, *d*) and become continuous with those from the dendrite (*a*). From the base of the dendrite (*b*), small fibrillar bundles are distributed toward the neuraxone. From the dendrites *c*, *d*, the bundles of fibrils arise, and run toward the neuraxone. Along their course, these bundles are increased by the addition of numerous bundles of fibrils which come

from the periphery of the cell-body to form the yet larger bundles found in the axone hillock. The dendrites *a* and *b* are subdivided into two branches. In this case the branches are also connected by a few fibrils. These branches which are divided from the main dendrites (*a*, *b*,) receive fibrils from various regions of the cell-body.

From the above description, two important relations are evident: (1) That each dendrite is connected by the fibrillar bundles with several and possibly all the others, and (2) in each case, the nucleus is partially surrounded or encircled by the fibrillar bundles, on their way from the dendrites to enter into the neuraxone.

As a rule, the fibrils in the dendrites are very conspicuous, presenting long continuous lines, while in the cell-body they take tortuous or irregular courses, so that the cross-section of the cell-body presents minutely dotted areas, representing the cross-section of the bundles. From this, it is inferred that the entire course of some of the bundles must be very complex.

Fig. 6 is a diagram reconstructed from the serial sections of the cell-body in order to depict schematically its structure and to show the fibrillar tracts distributed throughout it. Let us take any one of the dendrites from the Fig. 6, and trace the lines which represent the fibrillar bundles. In the dendrite (*b*), black continuous lines present the out-going fibrillar bundles, while dotted lines in the same dendrite represent the in-coming fibrillar bundles from other dendrites. If we trace one of the black lines (3), it enters into the dendrites which lie in both sides, and other black lines (1) run toward the nucleus and partially encircle it. The fibrils continue from the nucleus toward the axone and finally enter into the axis cylinder. In the remaining dendrites, the fibrillar tracts are just the same in their distribution with those of dendrites (*b*).

In some cases, the fibrillar bundles which run from the dendrite not only enter into the dendrites which lie nearest on both sides, but they also connect with other dendrites further distant (2). In the cross-section of the cell-body, we notice very often the following appearance: The neighbor-

hood of the nucleus is composed of peculiarly arranged fibrils, forming a "spiral" or "swirl." These appearances are caused by the fibrils, which take very irregular courses and partially encircle the nucleus in a tortuous manner.

III. Finer structure of the ground substance of the spinal ganglion cells in the adult white rat.

It remains to discuss the real nature of the fibrillar structures mentioned above, and to this end the structure of the ground substance of the nerve-cells must first be considered.

Concerning the structure of the ground substance in nerve-cells, two main views are held: the "fibrillar" and "non-fibrillar" structure. The former theory may also be subdivided. One view is represented by the theory of Bethe (*) who regards the ground substance as composed of "Peri Fibrillär Substanz" and "Fibrillen." The so-called Fibrillen are independent individuals distributed throughout the cell-body in a certain way, where they neither anastomose nor branch. Another fibrillar theory is that of Apàthy ([1]). According to this author, the primitive neurofibrils are to be distinguished by means of special technique, in the nerve-cells as Bethe describes. These fibrils however, are not isolated, but are connected with each other by means of delicate branches, thus forming a very complicated anastomosis within the nerve-cells.

The non-fibrillar theories may also be divided into two groups, represented by the theory of Apàthy ([1]), Nansen ([2]), Bütschli ([3]), etc. Nansen holds the view of primitive tubular structure of the formation of the ground substance of the nerve-cells, that is, the ground substance is entirely composed of extremely small tubules which are directly continuous with the neuraxone.

---

* Bethe, A.—Über die Primitiv Fibrillen in den Ganglien-zellen von Menschen und Wirbelthieren.—Arch. für Mikrosk. Anat., Bd. 51.

(1) Apàthy.—Das leitende Element des Nervensystems, u. s. w.—Mitheil. d. Zoolog. Station zu Neapel, B'd XII, '97.

(2) Nansen, F.—The structure and combination of the histological elements of the central nervous system.—Bergen, '87.

(3) Bütschli.—Investigations on microscopic forms and on protoplasm.—'94. Translation to English.

Bütschli, Held (1), Van Gehuchten (2), Von Lenhossek (3), Ramon y Cajal (4), Marinisco (5), Ewing (6), a. o., hold the view of reticular or spongy formation of the ground substance, stating that the fibrillar structure described by others are not true fibrils but rows of fine granules which form the reticular arrangement of the ground substance.

The writer's observations on this subject are as follows: The ground substance of the spinal ganglion cells of the white rat exhibits a reticular structure as shown in Fig. 7. The meshes of the reticulum are very small but conspicuous. The size and form of the meshes vary. Generally, in the clear zone at the periphery of the cell-body, the meshes are always larger and more conspicuous than in the remaining part. In the neighborhood of the axone hillock the meshes are not only much diminished in size, but also they are much elongated along one axis. Around the nucleus, the meshes reach a minimum size. The form of the reticulum at the periphery shows meshes of a somewhat polygonal shape, but in the remaining part of the cell these meshes are elongated, especially around the nucleus and near the neuraxone. Upon examining with a higher magnification, the protoplasmic threads or filaments which forms the reticulum, we see that it is not smooth but has a somewhat varicose appearance, due to the presence of small bead-like arrangements on the course of the filaments. This bead was called by Held (*) a "neurosome," who discovered the occurrence of the neurosome not only at the connecting point of the net but also inside the net. The writer noticed the occurrence of these structures not only at the connecting points of the net but also in the course of the filament, but could not find them inside the reticulum.

---

(1) Held.—Beiträge zur Strukturen der Nerven-zellen und ihren Fortsätze.—Erste Abhandlung. Arch. für Anat. und Entwickelungs. Anat. Abth., '95.

(2) Van Gehuchten.—Anatomie du systèm nerveux de l'homme.—Lauvain, 1894.

(3) Von Lenhossek.—Feinere Bau des Nervensystems.—'95. P. 147.

(4) Cajal.—Estructura del protoplasma nerviso.—Revista trimestral micrografica, Vol. I, fasc. 1, '96.

(5) Marinisco.—Pathologie gènèrale de la cellule nerveuse.—La Presse Médicale, '97.

(6) Ewing.—Studies on ganglion cells.—Arch. of Neurol. and Psychopathol., Vol. I, No. 3. '98.

(* Held.—Loc. cit.

This bead or neurosome has peculiar chemical affinities for the staining fluids. Eosin or erythrosin stain this element very deeply, so that it can easily be distinguished from the rest of structures. The fine filament joining these beads seems to be slightly different from the neurosome itself, as is shown by a slightly different staining reaction. It seems, indeed, that these neurosomes are a highly differentiated portion of the protoplasm which forms the reticulum.

The form and size of the neurosomes are different in different localities, as has been already described by Held. These structures are especially numerous within the axone hillock and intracellular extension of the axone. At the periphery of the spinal ganglion cells, the individual meshes of the reticulum are so large that the neurosomes are less crowded, hence, in this region, they are scattered very irregularly. But on the contrary, in the remaining parts of the cell, the meshes of the reticulum are elongated in shape and the rows of neurosomes become more crowded together, thus giving the fibrillar appearence. At first glance, this arrangement of neurosomes looks very much like the fibrils which have been described by many authors. Careful observations, however, show that these lines appearing like fibrils are composed of a row of minute beads arranged serially. Moreover, these pseudo-fibrils are connected by protoplasmic threads, thus forming the reticulum. This structure is shown in Fig. 7. Around the nucleus these neurosomes form somewhat concentric lines in a very beautiful manner. But gradually the figure becomes irregular as the reticulum approaches the periphery. This is the appearance generally found in the spinal ganglion cells. Sometimes the cell shows different arrangement of neurosomes, namely, concentric lines at the periphery but not in the neighborhood of nucleus. Still other variations in arrangement are found.

Graf (*) noticed the fibrils which are composed of a row of minute beads, in the Purkinji cells of human cerebellar cortex. He said: "The cytoplasma show the most beautiful fibrillar structure that I have ever seen. The fibrillæ are

---

* Graf, A — On the use and properties of a new fixing fluid chrom-oxalic. — Bull. of Pathol. Institute of the New York Hospitals, '97. Vol. II, p. 386.

exceedingly fine and are very regularly arranged in the cell-processes and on the surface of the cell, whereas they form a more intricate network in the center of the cell, especially around the nucleus. By closer observation of a favorable spot (the best places are where the stain is not very intensive) we notice that the finest cytoplasmic fibrillæ are not smooth, like smooth muscle fibrils, for instance, but are composed of a row of minute beads closely arranged in single file."

Held believes that the fibrils, according to some investigators, are in reality identical with rows of neurosomes. He hints that some of the fibrils represent bands of neurosomes; other fibrils described by Flemming are bundles of cytospongium.

My own observations support Held's suggestion. My preparations show sometimes exactly the fibrillar structure described by Graf, and I find this condition in the efferent neurones of the Torpedo, as well as in the spinal ganglion cells in the white rat. These fibrils can always be resolved into rows of neurosomes.

Another important point is, that the meshes of the reticulum in the cell-body become more and more elongated toward the axis cylinder. Thus it looks as if the fibrils are radiating from the axone around the nucleus.

The peculiar character of the region from where the axis cylinder originates was first described by Schäffer (1).

This region of the cell-body he called the "axone hillock." It is admitted by most investigators that the axone hillock, as well as the axis cylinder, show a parallel arrangement of cytoplasm. The writer notices also these arrangements of fine cytoplasmic threads, which carry the neurosomes, showing a convergent arrangement toward the axis cylinder. In this region the meshes of the reticulum are very small, but careful examination shows that the axone hillock, as well as axis cylinder, are composed of an altered reticulum.

The arrangement of neurosomes, except in the axone hillock, is not the same in all nerve-cells, but differs according to the type of the cells.

(1) Schäffer, K.—Kurze Anmerkung über die Morphologische Differenz des Axen Cylinders in Verhältnisse zu dem Protoplasmatischen Fortsätze bei Nissl's Färbung.—Neurol. Centralbl., Leipzig, Bd. XII, '93, S. 849–851.

In the motor ganglion cells in the anterior horn of the spinal cord, the neurosome presents quite a different arrangement from that of spinal ganglion cells. In the former group the meshes of the reticulum do not show the honey-comb form, but an elongated shape. The cytoplasmic thread carries a great number of neurosomes, which form straight chains. These chains run parallel to the periphery toward the dendrites, as well as toward the axis cylinder. Around the nucleus, however, these chains have the arrangement found in the spinal ganglion cells.

The Purkinjii cells in cerebellar cortex in the white rat show still a different arrangement of neurosomes. In these cells the neurosomes accumulate at the base of the main dendrites, showing very intricate arrangement. But near the entrance of the dendrites the irregular chains rearrange themselves, forming a regular line of neurosomic fibrils. The remaining part of the cell-body show nearly the same arrangement as that of the spinal ganglion cells.

IV.—Remarks concerning the structure of the ground substance in nerve cells.

As has been mentioned already, the ground substance of the spinal ganglion cells of the white rat presents very clearly the reticular structure. This structure, however, is altered by the growth of cell-body; for example, the prolongation of the axis cylinder from the cell-body is accompanied by an elongation of the primitively polygonal meshes of the reticulum, thus giving a fibrillar appearance to the ground substance.

The same holds true in the case of the Torpedo. The apparent fibrils result from alterations in the reticulum, and, therefore, should not be compared to those of Bethe's. Although, in the case of the Torpedo, the reticulum is hard to see, yet it is sometimes clearly demonstrable in thin sections properly stained.

In the spinal ganglion cells of the higher mammalia, except in Dogiel's second type of cells, the cell-body sends off only one prolongation, while in the case of Torpedo, the efferent

neurones of the electric organ give numerous processes from the cell-body. In the former case, the meshes of the reticulum are changed gradually from a regular polygonal form to those much drawn-out in the axone hillock. In the case of the Torpedo, however, the arrangement of the reticulum is modified not only toward the axis cylinder, but in every part of the cell-body from which dendritic processes arise. The appearances in Torpedo can be explained as a result of the growth changes of the cell-body. Judging from what we find in the rat, we assume in the first place the spinal ganglion cell to be a spherical mass filled by the wide meshed reticulum. For the same reason we assume that this spherical mass is pulled out at each point where there is a dendrite, and thus modified as it is where the neuraxone is formed from the axone hillock. As a result, the primitive polygonal meshes are transformed mechanically by the growth changes and thus give rise to the fibrillar appearance. If numerous processes are formed by the cell, as in the case of Torpedo, then the resulting appearance is quite complex. But the principle of its formation is the same as in the more simple spinal ganglion cell. The so-called fibrillar arrangement in the writer's preparation is thus explained:

V.—Summary.

1. The efferent neurones of the electric lobes of *Torpedo occidentalis* present a fibrillar appearance of the ground substance.

2. This appearance, however, is due to an alteration in the shape of the meshes of the reticulum, and, therefore, it cannot be compared with the fibrils described by Bethe, Apàthy, and others.

3. The meshes of the reticulum, which are regarded as the primitive by the present writer, are altered by the growth of the cell-body where the processes, both axone and dendrite, arise and become extremely elongated in these branches.

4. Gradations from the primitive shape of the meshes to the altered form which appears fibrillar, are clearly visible in the spinal ganglion cells of the white rat.

VI.—ILLUSTRATIONS. (Plate I.)

FIG. 1-5—Five serial sections from a single efferent neurone in electric lobe of *Torpedo occidentalis.* Mean diameter of the cell-body (120μ x 83μ); of the nuclei (37μ x 34μ).

FIG. 6—Diagram showing the fibrillar arrangement of the efferent neurone in an electric lobe of *Torpedo occidentalis.*

FIG. 7—Spinal ganglion cell from the mid-cervical ganglia of the adult white rat. Cell-body (41μ x 30μ); nucleus (15μ x 15μ).

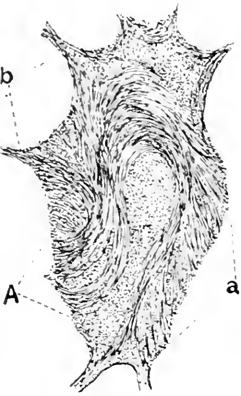


Fig. 1.

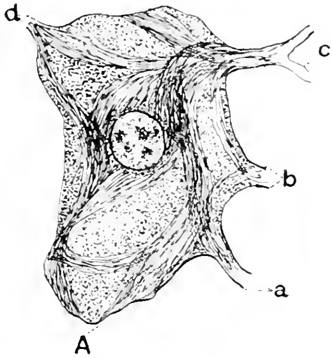


Fig. 2.

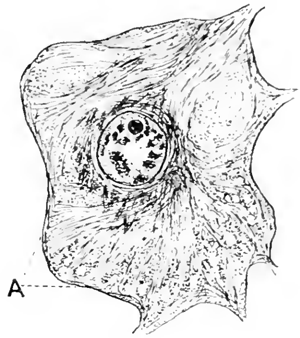


Fig. 3.

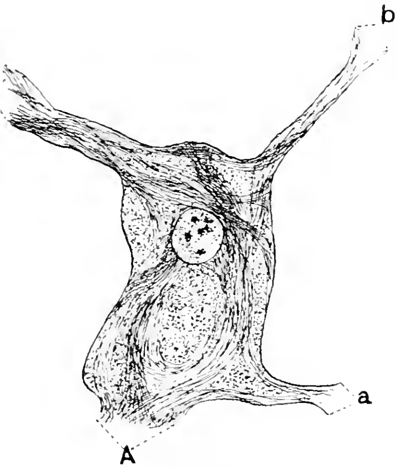


Fig. 4.

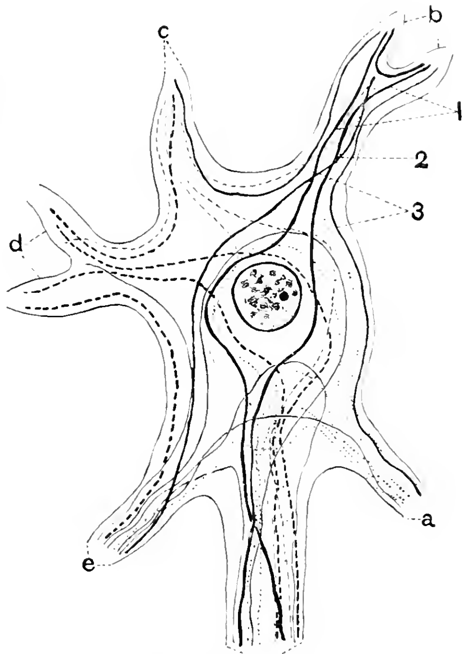


Fig. 6.

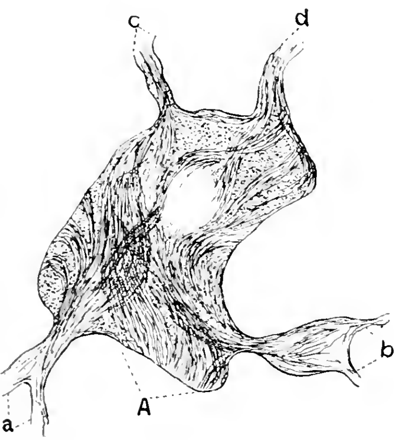


Fig. 5.

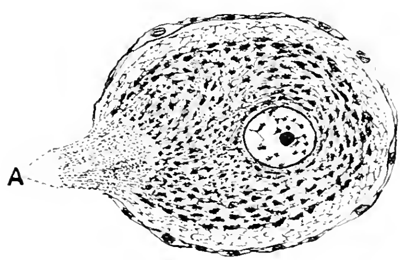


Fig. 7.

AN INVESTIGATION OF THE VASCULAR SYSTEM OF BDELLOSTOMA DOMBEYI.

The *Cyclostomata* derive their interest and importance from the fact that they are not only the lowest of the *Craniata*, but also possess many structural features which are undoubtedly ancestral in their character. As Dr. Ayers has maintained, too little attention has been paid to this class, especially to the Myxinoid division. With the exception of Johannes Müller's "Vergleichende Anatomie der Myxinoiden" (published 1834–1842), the Myxinoids, especially Bdellostoma, have scarcely been touched. A closer examination of the anatomy of the blood-vascular system of Bdellostoma, and a discussion of a few points concerning its comparative anatomy in the light of our present knowledge, is the purpose of this paper.

The material used in the following investigation included several injected specimens, and a large number of uninjected specimens of *Bdellostoma dombeyi* collected by me during the summer of 1897, in the Bay of Monterey, at Pacific Grove, California. Carmine-gelatine was used for injection, and the specimens were preserved in alcohol-formalin mixture (95 per cent alcohol, 6 parts; 2 per cent formalin, 4 parts). For comparison I have used specimens of *Bdellostoma forsteri* (from the Cape of Good Hope), *Petromyzon*, *Myxine*, etc., belonging to Dr. Ayers, under whose direction the following investigation was made.

THE HEART.

(Figures I, II, III, also, IX, X, XIV).

The heart is composed of three chambers — sinus venosus, auricle, and ventricle.

The *sinus venosus* (Figs. I, II, S), (gemeinschaftlichen Körpervenenstamm of Müller), is that part of the heart which

receives the blood from the venous system. It is an elongated thin-walled sac, about 2 cm. in length, situated a little to the left of the median line, just above the anterior lobe of the liver, and between the sheets of mesentery which form the hepatic ligament. The larger posterior portion lies just below the alimentary canal, and anterior to the gall cyst. The smaller anterior portion lies beneath the auricle (A). The sinus lies outside the pericardial cavity, but is partially enclosed between the layers of the mesocardium. It is dilated posteriorly, being somewhat quadrilateral in outline, and compressed laterally. In this region the sinus receives, on the right side, the anterior and posterior hepatic veins (ha, hp). At the posterior extremity it receives the posterior common cardinal trunk (pcc). Anteriorly, it receives, on the left side, the left anterior cardinal vein (acl). The narrow anterior portion of the sinus venosus receives the inferior jugular vein (jv) just anterior to the sinu-auricular aperture, which lies in the dorsal wall near the anterior end.

The *auricle* (Figs. I, II, III, A) lies immediately above and anterior to the sinus. It occupies the left portion of the pericardial cavity, and is surrounded by the pericardium (its relations to which will be described in detail later). The auricle is the largest of the cardiac divisions, and, when expanded, almost completely fills the left pericardial cavity. When contracted, however, it is smaller than the ventricle, since it is very thin-walled. It is an elongated sac, irregular in shape, and flattened dorso-ventrally. The exact position and extent varies considerably in different specimens. It is somewhat irregularly convex, except the inner and upper walls. These are usually concave, on account of being closely apposed to the ventricle during life. The auricle usually lies for the most part on the left side of the alimentary canal. Posteriorly, the auricle is closely connected ventrally with the sinus, communicating with it through the sinu-auricular aperture. On the right side it communicates with the ventricle through a short canal, the *ductus auricularis*. (See Figs. I and II.) This duct, though well marked in some specimens, is obscured in others by the approximation of the auricular and ventricular walls. It is really a constricted portion of the auricle at the auriculo-ventricular aperture. The margin of the auricle

behind this duct usually projects as a lateral pocket into the right pericardial cavity. The auricle is attached ventrally and internally (*i. e.*, to the left) by the mesocardium. The anterior and posterior extremities of the auricle, however, project freely into the over-lying pericardial cavity.

The cavity of the auricle (Fig. III) is very irregular. Beside the three pocket-like spaces (anterior, posterior, and lateral), the cavity is made irregular by a network of muscular trabeculæ which project from the walls, and sometimes across the cavity. The auricle has two openings. The afferent, or sinu-auricular aperture, is in the posterior portion of the floor. On viewing the floor from above, the long narrow slit-like opening is seen extending diagonally from side to side. The opening is guarded by two thin membranous valves (Fig. III, sav), whose free margins readily allow the influx of blood, but effectually prohibit its reflux. A short distance anterior from the sinu-auricular opening we find the auriculo-ventricular aperture, an oval foramen, on the right side in the duct previously described. This aperture is also guarded by a pair of valves, semi-lunar in shape, one lying anterior and the other posterior to the opening. These valves are smaller but stronger than the sinu-auricular valves. During the flow of blood from the auricle into the ventricle they lie flattened against the sides of the duct, with their free margins extending toward the ventricle and offering no resistance to the flow of blood. During the ventricular systole the valves prevent the reflux of blood by the apposition of their free margins in the median line, completely closing the channel.

The *ventricle* (Figs. I, II, III, V) is an ovoidal sac, slightly elongated and flattened dorso-ventrally. The lateral margin on the left side, next to the auricle, is less convex than that on the right. The ventricle is nearly in the median line of the body, just below the alimentary canal. It lies to the right of the auricle, somewhat ventral and anterior to it. The wall of the ventricle is much thicker than that of the auricle, and encloses a cavity shaped like a Scottish bag-pipe (See Fig. III). The inner surface of the wall, like that of the auricle, is marked by projecting muscular trabeculæ. There are two openings into the ventricular cavity. The afferent,

or auriculo-ventricular is an oval forámen situated near the posterior end on the inner side. It corresponds to the end of the short ductus auricularis already described. The foramen ordinarily measures about a millimeter in diameter in individuals of fifty centimeters length. The afferent or aortic aperture lies at the anterior extremity of the ventricle. It is nearly circular in outline and is likewise guarded by a pair of strong semi-lunar valves, one dorsal and one ventral. These are the strongest and thickest of the cardiac valves. They contain much elastic tissue, and are continuous with the walls of the aorta at its base. Their action is similar to that of other valves.

Pericardial Cavity.

The alimentary canal in Bdellostoma is suspended from the mid-dorsal line of the body wall by a mesentery, which is formed by the reflection of the lateral peritoneal sheets. (See Fig. IV., m.). Ventral to the alimentary canal, in the anterior abdominal region, the liver is likewise enclosed by a continuation of the same mesentery. (See Fig. V, L). Above the anterior lobe of the liver, the lateral peritoneal sheets do not meet above the alimentary canal to form a distinct mesentery. They are widely separated, and in the space between them the pericardial cavity is formed, just above the anterior lobe of the liver. The relations of the peritoneal and pericardial cavities are shown in diagram VI, which represents a cross-section through that region. For convenience of description, we may conceive of the pericardial sac as formed by an evagination of the peritoneal membrane on the right side into the space above the anterior lobe of the liver, and below the alimentary canal. The sac formed by this evagination is in turn *invaginated* by the pushing in of the heart (V) from below. In this way the pericardial membrane becomes arranged to form a double wall made up of two layers — an outer (O), or parietal layer, which encloses the pericardial cavity (pcc), and which is reflected to form the inner, or visceral layer (i), which immediately invests the heart. By the approximation of the pericardial layers, where they are reflected over the heart, a ventral cardiac ligament, the *mesocardium* (cm) is formed. The mesocardium partially separates the general pericardial cavity into two unequal divi-

sions, right and left. These two cavities communicate freely with each other dorsally (above and behind the heart), but are entirely separated ventrally. The right pericardial cavity, which is the larger, remains in free communication with the peritoneal cavity through the *pericardio-peritoneal foramen* (pcf). The heart has therefore exactly the same relation to the pericardium and the pericardial cavity as the intestine has to the peritoneum and the peritoneal cavity. There is only this difference, that the mesentery is *dorsal* to the intestine, while the mesocardium is *ventral* to the heart.

The right pericardial cavity may be described approximately as an elongated lenticular cavity, 2–3 cm. long, flattened dorso-ventrally, and lying just above the anterior portion of the anterior lobe of the liver. The anterior end of the cavity is larger and extends somewhat toward the right. It includes that portion of the cavity which contains the ventricle. The posterior end of the cavity is narrower, and extends backward and toward the left. The right pericardial cavity, as a whole, is bounded above by the dorsal body wall; below by the anterior lobe of the liver; internally by the mesocardium and the intestine (which it partially surrounds); and externally by the reflected peritoneum, which lies for the most part against the dorso-lateral body wall. An imperfect septum, the *portal septum*, complete only in the posterior region, is formed by the reflection of the roof into the right pericardial cavity. It extends parallel to the long axis of the cavity, and partially divides it into two chambers — a smaller *outer* and a larger *inner* chamber. This double-layered portal septum in the middle portion surrounds the portal heart; anteriorly, the anterior portal vein runs between its walls; and posteriorly it surrounds the common portal vein.

The *outer chamber* of the right pericardial cavity lies external to the portal septum. It is a narrow cavity, about 2–3 cm. in length, lying parallel to the inner chamber. It communicates with the inner chamber below the septum throughout almost its entire length. Only the extreme posterior portion of the outer chamber, into which the lateral wall of the alimentary canal projects, is completely separated by the septum from the inner chamber. In the posterior region the outer chamber communicates laterally and externally with

the general peritoneal cavity, through a narrow slit about 1–2 cm. in length — the pericardio-peritoneal foramen. (See Figs. VI, X, XIX, pcf). The direction of the slit is not quite longitudinal, but extends slightly outward anteriorly. The lower margin of the foramen is formed anteriorly by the fold extending upward from the liver (hepatic ligament) (See Fig. VI). Posteriorly, the slit borders on the lateral wall of the alimentary canal. The upper margin of the slit is formed posteriorly by the body wall and anteriorly by a reflection of the peritoneum from the wall. Through the pericardio-peritoneal foramen passes the supra-intestinal vein closely attached to the lateral wall of the intestine. The anterior extremity of the *right mesonephros* extends through the foramen, projecting from the inner side of the roof. The floor of the outer chamber is formed anteriorly by the upper surface of the anterior lobe of the liver; posteriorly, by the fold extending from the upper surface of the lobe to the lower margin of the pericardial foramen. The roof of the outer chamber is in direct contact with the body wall. External to the portal heart, toward the anterior end of the chamber, the *right pronephros* projects downward and outward into the cavity, pushing the pericardium before it. Just behind the pronephros, and above (outside) the pericardium, along the inner margin of the chamber, lies the anterior end of the mesonephros, which extends backward through the pericardial foramen, as described. In the posterior region the outer chamber lies against the right side of the intestinal wall. Along this wall a fold of the pericardium extends from the pericardial foramen to the posterior end of the portal heart. This fold encloses the *supra-intestinal* vein. (See Fig. XIII.)

The *inner chamber* of the right pericardial cavity lies internal to the portal septum, and encloses the ventricle of the heart. It is much larger than the outer chamber, being of about the same length, but wider and deeper. The inner chamber is situated slightly ventral to the outer. Anteriorly, the chamber is about ¾ cm. deep. Posteriorly, it becomes shallower and narrower, terminating just anterior to the gall bladder, and above the anterior lobe of the liver. On the left side the inner chamber forms a blind sac into which a

lobe of the auricle projects. The roof of the inner chamber is in contact with the ventral surface of the alimentary canal. The floor lies upon the dorsal surface of the anterior lobe of the liver. The anterior wall lies against the connective tissue surrounding the last gill pouch on the right side. The external wall is formed by the portal septum, which is incomplete ventrally, leaving an extensive communication with the outer chamber. The inner wall is formed by the mesocardium, which is also incomplete. Above the mesocardium is a narrow longitudinal slit (about 1 cm. in length) through which the right and left pericardial cavities communicate. The ventricle of the heart occupies the anterior portion of the inner chamber. The double-layered mesocardium passes upward and outward from its attachment, soon dividing into two sheets which form the inner pericardial layer immediately surrounding the ventricle. (Fig. VI.) Anteriorly the inner pericardial layer becomes continuous with the outer, forming no pericardium. In this way the anterior end of the ventricle is *not covered* by the pericardium, but lies *outside* the pericardial space. The mesocardium is attached ventrally to the left margin of the anterior lobe of the liver. Posteriorly it encloses the sinus and veins opening into it.

The left pericardial cavity lies on the left side of the mesocardium, somewhat dorsal to the right cavity. It is a small elongated sac, which closely surrounds the auricle. The roof is in contact with the alimentary canal internally and the dorsal body wall externally. The floor and external walls touch the latero-ventral body wall. The inner wall is formed by the incomplete mesocardium, leaving the right and left pericardial cavities in communication dorsally. The exterior wall abuts against the postero-dorsal wall of the oesophago-cutaneous duct. Posteriorly, the cavity ends as a short blind pocket. From the roof the left pronephros and the left anterior cardinal vein project into the cavity, pushing the pericardium before them. The mesocardium extends into the left pericardial cavity and surrounds the ventricle on the right side. The postero-internal angle of the auricle often extends through the slit-like foramen above the mesocardium, and lies in a pocket within the right pericardial cavity. This relation is not constant, however.

Arterial System.

The *ventral aorta* (Figs. X, XVIII, Av.) consists of a principal median trunk, which divides anteriorly into a pair of lateral branches. The main trunk lies in the median line, just above the ventral body wall and below the pharynx. The length is about 3 cm. The lateral branches are a little longer. It extends from the anterior end of the ventricle to the posterior extremity of the "club-muscle." It lies between the last six or seven pairs of gills, and is imbedded in the peculiar brownish fatty connective tissue characteristic of that region. The median trunk of the aorta is nearly cylindrical in shape, but narrows slightly in caliber anteriorly. Posteriorly, at its junction with the ventricle, it is suddenly constricted. The relatively small opening from the ventricle is guarded by a pair of strong semi-lunar valves, as previously described. The short expanded portion of the aorta just beyond the constriction and behind the first gill branches represents the *bulbus aortæ*. This portion of the aorta is in contact ventrally with the dorsal surface of the anterior lobe of the liver.

The ventral aorta divides anteriorly into two branches (right and left) which pass forward, upward, and outward, along the dorso-lateral aspect of the posterior end of the club-muscle. The posterior end of the club-muscle, with reference to the point of branching, is variable, on account of the mobility of the former. The usual position is shown in Fig. X. But the muscle may be drawn forward, or even back below the point of division.

The *afferent branchial arteries* (Figs. X, XVIII, af. br.) rise on either side from the ventral aorta and its right and left branches. There are usually six or seven pairs arising from the median trunk, and from three to six pairs from the branches. Sometimes there is one more on one side than on the other, corresponding to the asymmetrical occurrence of the gills. The six or seven pairs from the median trunk are never symmetrically disposed. The last afferent branchial artery on the right side is always posterior to the corresponding left vessel. (See Fig. X.) The two pairs lying next anterior to the last are situated nearly opposite to each other,

while the remaining vessels from the median trunk are asymmetrical, the *left* vessels arising anterior to the corresponding vessels on the right side. The afferent branchial arteries arising from the right and left branches of the aorta are also asymmetrically placed, corresponding to the asymmetry of the gills. The afferent vessels vary in length, the anterior vessels being longer than those in the posterior region. Those from the main trunk are about 1–1.5 cm., while those from the lateral branches are 1.5–3 cm., increasing from behind forwards. The most anterior vessel is always the longest. In size they are all about equal. The direction of the arteries is external and slightly upward in the arteries from the main trunk, and forward, upward, and outward in those from the lateral branches. Each afferent branchial artery terminates on the postero-external wall of the corresponding gill pouch, just below the external gill passage.

The last afferent branchial artery of each side gives off a small branch a short distance from the gill. This branch possesses a lumen only at its origin, if at all. It soon becomes reduced to a slender string of connective tissue which becomes lost in the connective tissue around the "club-muscle." Attached to this string is a small spheroidal body, apparently made up of fibrous and fatty tissue. (See Fig. X, XIV.)

It may be remarked that in *Bdellostoma forsteri* this string may be traced from the branchial artery around to the dorsal aorta. The significance of these structures will be discussed later.

Branchial Circulation.

(Figs. VIII, IX, X, XIII.)

The gills of the Bdellostoma are lens-shaped pouches, compressed laterally, so as to be concave on the inner face and convex on the outer. The pouches are not circular in outline, but more nearly elliptical, being elongated dorso-ventrally. The gill, as a whole, has two faces and four borders—superior, inferior, anterior, and posterior. The anterior and posterior are usually indented so as to be slightly concave, instead of convex. The afferent gill passage enters at the middle of the concave *inner* wall of the gill. (Fig. XIX.)

The efferent gill passage is given off from about the center of the convex *outer* wall. (Fig. X.) The line through these openings I shall call the axis of the gill. The internal anatomy is complex. The mucous membrane of the inner walls is folded to form a number of plates which are parallel to the axis of the gill and extended radially toward the center. (Fig. IX.) There are about twenty large plates, and a large number of smaller ones. The latter extend only a short distance in from the wall, and fill in the spaces between the bases of the other gill plates. Each plate is thrown into folds, only moderately near the base, but to an extraordinary degree of complexity toward the center. In this way a large amount of respiratory surface is developed. The free central margin, like the attached base of the plate, is strong and only slightly branched. These parts seem to serve merely as supports for the extremely thin respiratory leaflets. The inner surface of the gill wall, and the thicker supporting parts of the gill plates are covered with a stratified epithelium. The delicate respiratory leaflets are covered with a thin pavement epithelium. Next to the epithelial membrane occurs a small amount of connective tissue surrounding the blood vessels. Externally, the wall of the gill pouch is composed of a double layer of striated muscle — the external layer of *circular* fibers, the internal of *longitudinal* fibers (parallel to the axis). Surrounding the muscular layer is a thin serous membrane, which lines the lymphatic peri-branchial spaces.

The general distribution of the blood vessels in the gills is as follows: The *afferent branchial artery* of each gill passes under the lower margin of each gill pouch, then upward over the convex outer gill wall, which it enters just below the external gill passage. Some small twigs are given off which supply the gill passage and the muscles of the gill wall. The afferent artery then divides into two branches which surround the opening of the gill-passage, forming an irregular "ring vessel." From this "ring vessel" several radial vessels, often dilated into sinuses, are given off which pass within the gill wall toward the peripheral margin. Branches are given off which extend along the attached margin of each gill plate, beneath the muscular layers of the gill wall. From these branches numerous smaller vessels pass directly into

the gill plate. Their general direction is parallel to the axis of the gill, and perpendicular to the walls of the gill pouch. These smaller vessels break up into capillaries, which ramify between the thin epithelial walls of the respiratory gill leaflets. In this region an extensive capillary network is formed, and anastomoses between the larger vessels are also common. Toward the opposite (*i. e.* the inner) attached edge of the gill plate, and in the free central margins, the capillaries again unite to form larger vessels. These efferent branchial vessels converge on the inner wall of the gill pouch in much the same way as they are distributed in the outer wall. They unite under the muscular layer into sinuses and vessels which finally unite to form the efferent branchial artery of each gill pouch. This vessel leaves the gill wall just above the internal gill passage. (Fig. XIX, ef, br.) A diagrammatic representation of the branchial circulation is shown in Figure XIII, which respresents the vascular distribution in a plane parallel to the gill axis. Figure IX shows a drawing of a section of an injected gill made perpendicular to the axis of the gill, and near its center. The low magnification fails to give an adequate idea of the great complexity in the formation of the gill leaflets. Figures VIII and XIV represent small portions of these leaflets magnified to show the capillary vessels, which are composed of a single layer of epithelial cells. The larger vessels have walls composed of three layers,—an outer layer of connective tissue, a middle layer of circular muscle fibers, and an inner simple endothelial layer.

The *efferent branchial arteries* (Figs. XVIII, XIX, XX, ef, br) arise from the inner face of each gill pouch, just above the internal gill passage (gpi). Each efferent vessel extends upward and inward toward the median line. In the posterior region each vessel ascends just behind a "gill constrictor" muscle, then turns forward immediately *above* it and joins the overlying common carotid just anterior to the muscle. There are never *two* efferent vessels for each gill-pouch, as is commonly the case in *Bdellostoma forsteri*. All the efferent branches of each side open into the corresponding lateral common carotid.

General Arterial System.

The *common carotid arteries* (right and left) posteriorly extend longitudinally along each side above the gills and beside the pharynx. (Figs. XVIII, XIX, XX, Car.) Externally, they connect with the efferent branchial arteries; and internally, by means of from four to seven short commissural vessels (comv) on each side, they communicate with the median dorsal aorta. These commissural vessels usually arise nearly opposite the fourth or fifth to the eighth or tenth pairs of gills. Posteriorly the common carotids are connected with the dorsal aorta nearly opposite each other, and a short distance behind the last pair of gills. Anteriorly they continue forward on each side of the pharynx, giving off numerous small twigs to this organ. Each carotid also supplies the club muscle with several branches. The most posterior pair of these branches seem to supply only that portion of the muscle connected with the longitudinal *retractor* fibers. The remaining branches supply the circular *constrictor* portion. The branches to the "club-muscle" run in the sheet of connective tissue which connects the muscle to the dorsolateral body wall on each side.

Just behind the cartilaginous "pharyngeal basket" of the branchial skeleton, each common carotid divides into two branches, the *external* and *internal* carotid arteries. Each external carotid passes forward and downward around and outside the pharyngeal basket and runs forward along the outer margin of the basal plate. Near the junction of the posterior with the anterior segments of the basal plate, a small branch is given off which passes upward and inward to the ligament attaching the dental plate (*ramus lingualis*). This branch supplies the dental plate but apparently not the muscles moving it. The main trunk of the external carotid then passes forward along the external margin of the basal plate on each side giving off small twigs to the lateral walls of the skull. Anteriorly it breaks up into a number of small branches, which supply the muscles and integument in the tentacular region.

Each *internal carotid* continues inward and forward just above the pharynx. (See Figs. XVIII and XX.) A rela-

tively large lateral branch is given off on each side which runs forward and supplies the muscles in the lateral region of the head. In one instance I traced this vessel (on the left side), forward under the lateral trunk muscles just outside the skull wall, under the hyoid arch, and out into the orbital region, sending a branch out to the skin, in the fibrous band of connective tissue just below the eye. The main trunk of the internal carotid joins the corresponding vessel of the opposite side in the median line just below the notochord and in front of the supra-pharyngeal plate. (See Fig. XX.)

The *vertebralis impar* (v), formed by the junction of the internal carotids, runs forward a short distance in the median line beneath the notochord, giving off branches to the brain and cranial wall. Passing below the cranium, just behind the pituitary sac, it divides into two lateral branches, right and left, which run forward on each side of the base of the cranium to the nasal and anterior head region.

The *anterior dorsal aorta* (Figs. XVIII, XIX, XX, Aa) is that portion of the median dorsal aorta which lies in, and in front of, the gill region. Posteriorly, it begins with the most posterior point of connection with the lateral carotids. It lies immediately above the pharynx, and below the notochord. In the gill region, the anterior dorsal aorta gives off four or five pairs of branches to the body wall (somatic branches). The posterior, three pairs of these usually pierce the overlying "gill constrictor" muscles. In the anterior gill region, the aorta curves slightly to the right, and continues forward beneath the right side of the notochord. In one instance it turned first to the left, ran forward two or three somites, then passed over to the right and forward as usual.

Anterior to the gill region it gives off in its course seven or eight pairs of somatic branches to the adjacent segments of the body wall. In general, an artery is given off to each alternate myoseptum on each side. Each somatic vessel divides into two branches, dorsal and ventral, whose course is the same as that of those to be described in the abdominal region (see Fig. XV). There are some variations in the distribution of the branches of the anterior dorsal aorta,

however. The arteries, like the corresponding myotomes, are not arranged in bilateral symmetry. The branches are given off *alternately*, especially in the anterior region. (See Fig. XX.) A short distance behind the junction of the internal carotids, the anterior dorsal aorta crosses over and joins the left internal carotid, just behind the origin of the lateral branch.

The *posterior dorsal aorta* (Figs. XII, XV, XVIII, XIX, XX, Ao), is the posterior continuation of the same vessel which anteriorly forms the anterior dorsal aorta. Beginning behind the junction with the lateral carotids, the posterior dorsal aorta gives off branches as follows:

(*a*) A pair of *somatic branches*, and usually a mesenteric twig to the intestinal wall.

(*b*) Twigs to the right and left *pronephros* (pnl, pnr). These may come off as separate twigs, but usually arise in common with somatic branches (Fig. XIX).

(*c*) The *coeliac artery* is a relatively large vessel. It occasionally gives off a twig to the left pronephros. It then passes downward between the sinus venosus and the alimentary canal (to which it gives off a small branch). The coeliac artery then proceeds along the common bile duct to the gall-cyst, which it supplies. Then it divides into two terminal vessels, anterior and posterior, which pass along the bile ducts to the anterior and posterior lobes of the liver. Here they break up into capillaries which supply these structures.

(*d*) *Mesenteric arteries* (Figs. XII, XV, XVIII, mes) are given off ventrally, which pass downward between the right and left posterior cardinal veins, in the mesentery, to the intestinal wall. Just above the intestinal wall they usually divide, one branch going to the right, the other to the left side of the intestine. Both branches pass to the left of the supra-intestinal vein, but pass one on each side of the vagus nerve, which lies in the median line just above the intestinal wall. There are about thirty mesenteric arteries, and they arise in a somewhat irregular manner. Often, however, they arise in couples, one a short distance behind the other (See Fig. XII).

(*e*) The *somatic arteries* arise regularly along the entire length of the dorsal aorta, anterior and posterior (Figs. XII,

XV, XVIII, XX, s). The somatic arteries, as a rule, alternate with the somatic *veins* on each side. (Fig. XII.) Those of the right and left sides are sometimes in pairs, opposite each other, but usually alternate, always corresponding to the arrangement of the myotomes on each side. The somatic arteries from the *anterior* dorsal aorta arise independently. Those from the *posterior* dorsal aorta usually arise by a short trunk in common with one or more renal branches (Fig. XII). Each somatic artery passes above the mesonephros, supplies it with one or more twigs, and then divides into two branches. (See Fig. XV.) The *dorsal* branch passes directly upward beside the notochord, supplying the lateral trunk muscles, and sending branches into the neural canal to supply the spinal cord. Then it passes up in the median longitudinal septum above the neural canal. It passes out to the skin of the dorsal region through the sheet of connective tissue which fastens the skin to the body wall.

The *ventral* branches of the somatic arteries correspond to the *intercostal vessels* of the higher vertebrates. (Figs. XII, XV, ic.) They pass outward along the roof and sides of the peritoneal cavity, between the lateral trunk muscles and the peritoneum. They pass along the septa between the myotomes, giving off many minute twigs to the adjoining muscles. (See Figs. XII, XV, ic.) Each "intercostal" passes along with (anterior to) the corresponding intercostal nerve (sn). After passing between two slime glands, which it supplies, each intercostal vessel gives off irregular branches to the ventral rectus trunk muscle in the vicinity. The end piece of each vessel passes out into the skin in the neighborhood of the slime glands, and is distributed to the integument of the ventral and lateral regions of the body.

(*f*) *Renal branches* are supplied segmentally to the mesonephros along each side of the aorta. A portion of these are shown in Figure XII, (r). (cfr. also Figs. XVIII and XX.) These renal branches supply the segmental glomeruli along the inner wall of the mesonephros. The glomeruli correspond to the myotomes only in a general way, and not exactly. Usually two glomerular vessels, and one or more twigs to the dorsal and inner walls of the mesonephros, arise from a common trunk with a somatic branch. There is

much variation in this respect, however. Sometimes a somatic and one renal vessel arise together, and sometimes the renal vessels arise independently.

(*g*) The *genital branches* (Figs. VII, XVIII, XX, gen) arise from all the mesenteric arteries in the region of the testis in the male, and the ovary in the female. Occasionally branches arise independently from the dorsal aorta. The genital branches pass out in the genital ligament (a special fold on the right side of the mesentery). Soon after entering this fold the genital vessels, for the most part, unite to form a longitudinal commissural vessel. (Fig. VII.) From this vessel a large number of smaller vessels run out toward the testis or ovary, branching and anastomosing freely. A capillary network is formed in the membrane surrounding each ovum, or lobule of the testis.

Behind the cloaca, the aorta continues immediately below the notochord in the median line, but here, as might be expected, only the somatic branches are given off. On reaching the median ventral plate, the aorta divides into a right and a left branch, each of which passes backward on the corresponding side of the plate. Lateral branches are given off to supply the muscles and integument of the caudal region. In the caudal fin, small vessels run out distally corresponding to each fin ray.

General Venous System.

The *veins* of the Bdellostoma may be included under two separate systems—the *general* system, and the *portal* system. The general venous system is larger, including all those veins through which the blood flows into the sinus venosus. (Figs. X, XI, XVII, XVIII, S.) Anteriorly where it empties into the auricle, the sinus is narrow, and receives the *inferior jugular* vein (jv). Posteriorly, behind the auricle, the sinus is dilated, and receives on the left, the *left anterior cardinal vein* (acl.) anteriorily, and the common cardinal vein (pcc) posteriorly. On the right side enter the anterior and posterior *hepatic veins* (ha, hp).

Beginning with the general venous system in the head region, we find the *superficial anterior cardinal vein.* (Figs.

XVII, XVIII, scd) arising on each side of the head. It leaves the cranium just dorsal to the corresponding vagus nerve. It passes backward alongside the vagus, between the lateral trunk muscles, and the constrictors of the pharynx. In this region it receives the first eight or ten somatic veins. These somatic veins, like the somatic arteries (with which they alternate), arise from the skin and trunk muscles the entire length of the body. They correspond exactly to the somatic veins of the abdominal region shown in Figure XV, (s). They are each composed of a very short terminal trunk which is supplied by two branches, (1) a *dorsal* branch which collects the blood from the dorsal region of the integument, the spinal cord, notochord and muscles of the vicinity. It descends vertically at the side of the notochord, and on reaching the ventral surface of the dorsal body wall, joins with (2) the *ventral* branch, or "*intercostal*" vein. The intercostal veins, like the intercostal arteries, are distributed to the integument of the ventral and lateral regions of the body, and the ventral rectus muscle. In the gill region, the intercostals receive, in the region of the slime glands, occasional "pleural" branches from the connective tissue. Then after collecting the blood from the two adjacent slime glands, it passes between these along the intermuscular septum of the myotomes, on the ventral surface of the dorsal and dorso-lateral body walls. The intercostal veins lie just in front of the corresponding intercostal nerves. As before mentioned, the intercostal veins usually alternate with the intercostal arteries (Figs. XI, XII, XV, XIX, ic), especially in the abdominal region. In the pharyngeal region the arrangement is less regular, there being often two adjacent arteries or veins, and occasionally both an artery or vein on *one* intermuscular septum. (Fig. XIX.) After receiving the somatic veins from the head region, the superficial cardinal pierces the constrictor muscle and joins the *deep cardinal* vein.

The *deep anterior cardinal* vein (Figs. XVII, XVIII, dcd) arises from the integument and muscles of the anterior head region. It passes on each side between the pharynx and hyoid arch (just below the posterior process), then directly backward alongside the pharynx, internal to the constrictors,

receiving branches, and passing under the first branchial arch, but over the second. About 2–3 cm. behind the second arch it is joined by the *superficial cardinal* to form the *common anterior cardinal* vein.

The *common anterior cardinal* (or jugular) veins, right and left (Figs. XVII, XIX, acr, acl), pass backward and beside the pharynx, just external to the corresponding carotid artery, and internal to the vagus nerve. They receive four sets of branches: (1) somatic veins from the body wall; (2) pharyngeal branches, (ph), numerous small twigs from the wall of the pharynx; (3) "club-muscle" branches, from the "club-muscle;" (4) "pleural" branches from the connective tissue in the pharyngeal region. Anteriorly, the courses of the right and left anterior common cardinals are similar. Behind the "club-muscle," however, they are quite different.

The *left anterior cardinal* continues in the same general direction backward beside the vagus, and above the gills. It receives the usual somatic branches, and also a few "pleural" twigs from the connective tissue surrounding the gill pouches. It also occasionally receives twigs from the walls of the gill passages and oesophago-cutaneous duct. Posteriorly (Fig. XI, acl), it forms a slight projection from the roof into the left pericardial cavity, as before described. It passes between the left pronephros, from which it receives a twig, and the alimentary canal, and empties into the antero-lateral angle of the dilated posterior portion of the sinus venosus.

The *right anterior cardinal*, on the other hand, toward the posterior end of the "club-muscle," leaves the pharyngeal wall, passes downward toward the posterior end of the "club-muscle," and crossing over toward the median line, empties into the *inferior jugular* vein. (Fig. XIX, jv) The remaining area corresponding to that supplied by the left anterior cardinal on the other side of the body is supplied by the portal system.

The *inferior jugular vein* (Figs. X, XVII, XVIII, jv) arises from the posterior end of the "club-muscle," from which it emerges on the ventral surface. It passes backward a little to the left of the median line, immediately over the ventral body wall. After receiving the right anterior cardinal

vein, it continues backward a little below and to the left of the median ventral aorta. (Fig. X.) It receives a varying number of branches from the body wall. It also receives several small "pleural" twigs from the connective tissue and gill passages, including the oesophago-cutaneous duct and the adjoining pharyngeal wall. Finally, the inferior jugular vein empties into the anterior end of the sinus venosus, just in front of the sinu-auricular aperture.

The *posterior cardinal veins* arise in the caudal region from small twigs which form two small veins. These lateral veins accompany the arteries on each side of the cartilaginous median ventral plate in the caudal region. (Fig. XVII.) They unite to form the *median caudal vein* (caud), which runs forward immediately beneath the caudal artery. The caudal vein, at its posterior end, is dilated to form a small sinus just in front of the median ventral plate. Laterally, the caudal vein receives, on each side, the somatic veins of the caudal region.

Anteriorly, in the cloacal region, the caudal vein divides into two veins, the *right* and *left posterior cardinal veins.* (Figs. XI, XII, XV, XVIII, XIX, pcr, pcl.) These vessels run parallel with each other, just below and on each side of the posterior dorsal aorta. The right posterior cardinal is much smaller than the left. (See Figs. XII, XV, XVII.) Each lies internal to and in contact with that side of the corresponding mesonephros which faces toward the median line. The posterior cardinals are joined by a large number of short transverse commissural vessels (about twenty-five in all). They are not placed at regular intervals, but are more numerous in the posterior region. They vary in size, being usually about as wide as the *right* cardinal vein. The posterior cardinals receive two sets of branches: (1) the renal branches; (2) the somatic veins.

The *renal branches* (see Fig. XII), appear to arise, for the most part, on the ventral surface of the mesonephros. They collect together and form small twigs, which run across toward the median line and empty into the corresponding posterior cardinal vein. These renal veins are somewhat irregularly distributed, but traces of their original segmental arrangement are easily recognized.

The *somatic* veins have already been described in a general way. Those of the abdominal region pass dorsal to the corresponding mesonephros (receiving no branches from them), and empty into the corresponding posterior cardinal vein.

The posterior cardinals receive no veins from the intestine. In one instance only I observed a branch from the testis running upward into the right posterior cardinal vein.

Anteriorly, a short distance behind the heart, the right and left posterior cardinals unite again to form the unpaired *posterior common cardinal vein* (Fig. XVII, pcc), which passes forward on the left side, and empties into the posterior end of the sinus venosus.

The *sub-intestinal vein* (Figs. XI, XV, XVII, XVIII, sub. int.) arises from the ventral wall of the intestine toward the anterior end. It passes forward along the median ventral line of the intestinal wall, and on reaching the hepatic ligament, passes down along its posterior margin to the posterior lobe of the liver. (Fig. XI.) In some specimens it passes through the tissue of the liver for a considerable distance, but in others it runs along the surface, within the serous membrane. It passes behind the liver, and runs forward on its ventral and external aspect. It receives branches from the posterior lobe of the liver, and becomes the posterior hepatic vein (hp). As such it passes upward, parallel and near to the bile duct of the posterior lobe. It becomes very much widened, and finally empties into the posterior end of the sinus venosus, opposite the common posterior cardinal vein.

The veins of the anterior lobe of the liver converge to form the *anterior hepatic vein*, which lies on the dorsal surface of the lobe. (Figs. XI, XVII, XVIII, ha.) This vein runs forward and upward, emptying into the left side of the sinus venosus, a little behind the sinu-auricular opening.

There is also apparently a small vein running in the ligament between the anterior end of the posterior lobe, and the posterior end of the anterior lobe. The veins from the gall cyst, as will be seen, join the portal system, and will be described there.

The Portal Venous System.

The portal venous system includes the portal vein and all the vessels which flow into it.

The *anterior portal vein* (Figs. XVII, XVIII, XIX, ap) arises in the right branchial region, a little in front of the posterior end of the "club-muscle." (Fig. XIX.) It lies just below and to the right of the notochord, and receives the somatic veins from the right side in the branchial region. A few scattering venous twigs from this region also pass across into the inferior jugular vein. The anterior portal continues backward into the fold (portal septum), separating the inner and outer chambers of the right pericardial cavity, as previously described. It passes between the alimentary canal and the right pronephros, and opens into the roof of the portal heart near the anterior end. The entrance is guarded by a pair of thin membranous valves, semi-lunar in shape, one anterior and one posterior. (See Fig. XVI, ap.) Just before entering the portal heart it receives a branch which is made up of a twig from the pronephros, and (often) two or three somatic veins lying opposite and posterior to the portal heart. In one instance, I observed an anastomosis between this vein and a somatic vein emptying into the right posterior cardinal vein.

The *supra-intestinal* vein (Figs. XI, XII, XV, XVII, XVIII, XIX, supr. int.) receives the blood from the entire intestinal wall, excepting the floor in the anterior region. It runs forward just above the intestine a little to the right of the median line, within the mesentery. It lies to the right of the vagus nerve and the mesenteric arteries. In the region of the reproductive organs the supra-intestinal vein receives several *genital veins* which descend in the mesentery. These veins are formed by the plexus of small venous twigs in the special genital fold of the mesentery (Figs. XII, XVIII, gen). On reaching the pericardial region, the supra intestinal vein turns to the right side of the intestine. Here it receives the *cystic vein* (Fig. XIX, cv), which is made up of branches from the gall cyst. The supra-intestinal vein then passes through the pericardio-peritoneal foramen, beside the intestine, and below the right mesonephros. It then crosses

the roof of the outer chamber of the right pericardial cavity just below the right vagus nerve, and enters the roof of the portal heart near the posterior end. (See Fig. XVI, supr int.) The slit through which the blood enters is diagonally placed, and guarded by a pair of semi-lunar valves, like those of the anterior portal.

The *portal heart* (Figs. X, XVI, XVII. XVIII, XIX, H.) lies in the pericardial fold which forms the septum in the right pericardial cavity. It is an elongated sac (1-2 cm. in length), somewhat irregular in shape and variable in size. It stretches diagonally across the pericardial cavity, and lies nearly opposite the ventricle (cf. Fig. X). Anteriorly it receives the anterior portal vein; toward the posterior end it receives the supra-intestinal vein. Both these enter dorsally. At its posterior extremity the portal heart empties into its efferent vessel, the *common portal vein*. The opening into the common portal vein is guarded by a pair of strong semi-lunar valves (Fig. XVI, cp), which are placed laterally, and like the other valves previously described, prevent any reflux of blood during the circulation.

Johannes Müller was mistaken in his statement that no muscle fibers exist in the portal heart of Bdellostoma.* The wall is quite muscular, fully as much as that of the auricle. As in the latter, the inner surface of the wall of the portal heart is made irregular by muscular and fibrous trabeculæ, which project from the surface. The muscle fibers are *distinctly striated*, and their nuclei seem to lie on the sides of (not within) the contractile fibers.

The *common portal vein* (Figs. XVII, XVIII, XIX, cp) continues backward and inward toward the median line. It passes above the anterior lobe of the liver, to which it gives off ventrally a large branch which descends almost vertically alongside the hepatic duct of the anterior lobe. (XI, cpa). The main trunk of the common portal vein then crosses the median line to the left side and passes backward and downward alongside the hepatic duct of the posterior lobe. (Fig. XI, cpp.) About the center of the dorsal surface it enters

*Vergl. Anat. der Myxinoiden (1834). Later Müller observed the pulsations of the portal heart in living Myxine. Untersuchungen über die Eingeweide der Fische (1842).

the posterior lobe and breaks up into capillaries in the tissue of the liver.

I have observed in several cases a marked tendency for the injected carmine gelatine to escape from the blood vessels into the surrounding lymphatics, which are very numerous and extensive. These lymphatic spaces, especially the sub-dermal spaces in the caudal region, and the peri-branchial spaces around the gill pouches, are usually found more or less injected, although the blood vessels show no signs of over-distension. The lymphatic spaces around the vessels in the gill itself are also often filled. This condition may be interpreted as indicating that the capillary walls are unusually weak and permeable, so that the injected liquid passes through them, carrying blood corpuscles with it. That this process is not normal is shown by the absence of red blood corpuscles from these lymphatic spaces in life, and in uninjected specimens.

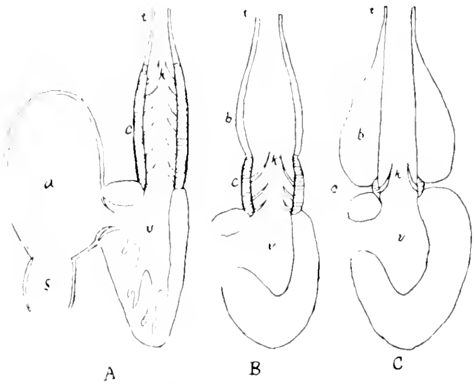
Remarks on Comparative Anatomy of Bdellostoma.

The communication of the pericardial cavity with the peritoneal cavity through the pericardo-peritoneal foramen is primitive. The heart, which is a specialized portion of the primitive sub-intestinal vessel, always develops at first in the anterior end of the general peritoneal cavity. In all adults, however, a special pericardial cavity is formed. In Petromyzon, whose pericardial sac is enclosed in a cartilaginous pocket, the separation is complete. In the larval Ammocœtes, however, there exist two larval pericardio-peritoneal foramina, one on either side. Communication between pericardial and peritoneal cavities exists also in Elasmobranchs and Ganoids, but only during embryonic life in all higher vertebrates.

Although its embryological development is not yet worked out, the sinus venosus doubtless at first receives a right and left *ductus Cuvieri*, like Petromyzon (Goette), and higher forms. The right ductus has probably been lost altogether in a manner which will be discussed later. The left ductus Cuvieri has apparently fused with the sinus venosus, and is represented by the external portion of the posterior expanded

division of the sinus, which still receives the right anterior and posterior cardinals.

In the absence of a contractile valved *conus arteriosus*, Bdellostoma and all the Cyclostomata resemble the Teleosts more than the Elasmobranchs. (See text figures A, B, C.)



A, Elasmobranch.
B, Ganoid.
C, Teleost.
s, sinus venosus
a, auricle.
v, ventricle.
c, conus arteriosus
b, bulbus arteriosus.
t, ventral aorta.
k, valves.
(From Boas's Zoology.)

In this respect the Bdellostoma is probably not primitive, since in the Sharks and Ganoids there is clearly a tendency to a reduction in the number of the valves and the size of the conus.*

Contrary to Müller's statement (Vergl. Anat. der Myxinoiden, pp. 180), the bulbus aortæ is *not* entirely devoid of muscular fibers. As in the arteries in general, there is a small amount of plain muscle fibers mixed with the thick layer of elastic fibers. The bulbus is evidently not contractile, however, in the ordinary sense of the word.

*It is quite possible, however, that the absence of a conus represents a condition more primitive than the Elasmobranch. No valved conus appears during the development of Petromyzon.

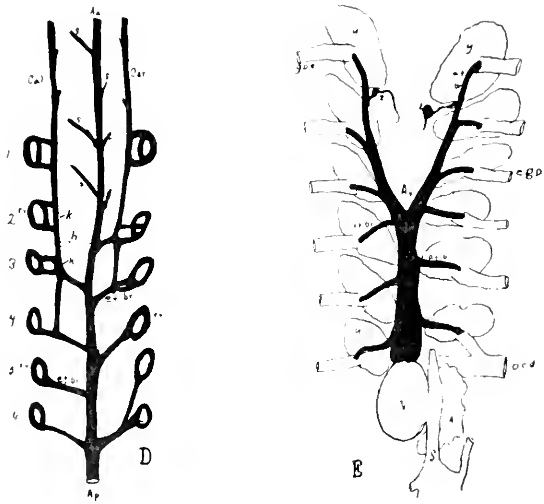
Variations from the structure of the typical ventral aorta, as previously described, are very common. As an extreme instance, I may mention a case mentioned by Müller, in which the ventral aorta, immediately after leaving the heart, divided into two branches from which all the afferent branchial arteries arise.

With respect to the "ductus Botalli," Müller noted the following in *Bdellostoma forsteri*:" "Ehe wir die Gefässe der Myxinoiden ganz verlassen, müssen wir noch einer Beobachtung gedenken, welche auf einen Entwickelungszustand des Gefäss-systems der Myxinoiden einiges Licht wirft. Ich habe nämlich bei dem grossen Myxinoid vom Cap wiederholt die Reste zweier ductus Botalli bemerkt, welche früher ohne Zweifel die *arteria branchialis* mit dem Arterien system in Verbindung setzten, jetzt aber ganz feine fadenartige Stränge bilden, deren Ursprung aus der *arteria branchialis* und Ende in Arteriensystem des Körpers aber noch hohl sind. Dieser Faden entspringt aus dem Aste der Kiemenarterie zur vordersten Kieme, in gleicher Weise auf jeder Seite. Bei seinen Ursprung ist er ansehnlich dick, conish und hohl, die Fortsetzung ist aber sehr fein, sie geht vorwärts aufwärts gegen die Carotis hin, wo diese aus den vordern Kiemenvenen entsteht, hier erweitert sich der Faden wieder, wird wieder hohl und senkt sich in die Anfang der Carotis ein. Aus diesem hohlen Ende des Fadens gehen einige feine Zweige zu den Pleuren ab. Diese Anordnung fand ich in gleicher Weise bei mehreren grossen Exemplaren von *Bdellostoma forsteri*. Ich habe sie auch bei den *Myxinen* gesehen. Diese obliterirten ductus Botalli waren offenbar früher weite Aortenbogen von dem *truncus arteriosus* des Herzens zu den Carotiden und von diesen weiter zur Aorta." (loc. cit., pp. 191.)

I have already described the same structures found in *Bdellostoma dombeyi*. In addition to the observation of Müller, I have added that a spheroidal or flattened mass of connective tissue is found attached to the "ductus" a short distance from its origin. This body is larger and more saccular in appearance in *Bdellostoma forsteri*. (See text figure E, z), and evidently may be interpreted as the rudiment of the *gill pouch* corresponding to the obliterated branchial artery. A similar ductus Botalli from the first branchial

artery is found in certain Caducibranchiata. In these cases, a "rete mirabile" persists in the course of the ductus, and represents the obliterated gill. (Balfour, Comp. Embryol. Vol II.)

Since the "ductus Botalli" is a constant feature in all specimens of *Bdellostoma* examined, its significance lies in



D, efferent branchial system of *Bdellostoma forsteri*, dorsal view.
E, heart and afferent branchial system of *Bdellostoma forsteri*, ventral view.
Ap. posterior dorsal aorta.
Aa. anterior dorsal aorta.
Car, right carotid.
Cal, left carotid.
ef. br, efferent branchial artery.
rv, ring vessel of gill passage.
S. sinus venosus.
A. auricle.
V. ventricle.
Av, ventral aorta.
afb, afferent branchial artery.
z, body on "ductus Botalli."
g, gill pouch.
gpe, external gill passage,
ocd, oesophago-cutaneous duct.

the fact that even in the 13-gilled forms, we have to do with a *reduction* rather than an *increase* in the *primitive number of gills*. The embryological development, according to Price (Some Points in the Development of a Myxinoid. Verhl. der Anat. Ges., 1896), renders this conclusion certain. A large

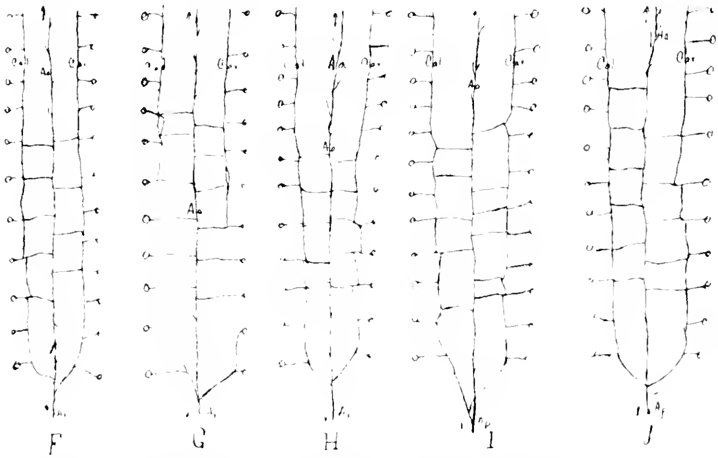
number of gill pouches (possibly thirty-five pairs) arise during the course of development. Of these, only the posterior 10–14 pairs remain to form the permanent gills of the adult.

The distribution of branchial vessels, one to each gill cleft (gill pouch), is a character in which the Myxinoids differ from all other Vertebrates. Even in Petromyzon, each afferent and efferent vessel is distributed to the *hemibranch* of *two different pouches*, the gill arteries corresponding to *gill-arches* rather than *gill clefts*. It is probable that the Myxenoid condition is not primitive, although the embryological development is not known. A probable explanation of the manner in which this unique condition has been derived from the primitive arrangement is suggested by an examination of the efferent branchial vessels and their connections in *Bdellostoma forsteri* (see text figure D.) Here we find, usually, *two efferent branchial vessels* (ef, br) arising from the ring vessel (rv) which surrounds the gill passage on the wall of the gill pouch. These efferent vessels unite with the lateral carotid vessels, and with the dorsal aorta by anastomoses. This is an interesting intermediate stage between the arrangement of the vessels in *Bdellostoma dombeyi* (see Plate III, Fig. XX), and the ordinary vertebrate type. Referring again to text figure D, suppose, for example, we take afferent vessels from gill 3. If we fuse the two vessels together (which is almost accomplished in the sixth gill, right side), or obliterate one of them, we get *one* efferent vessel for each gill, as in gills 4, 5, and 6, left side. This is the condition in *all* the gills of *Bdellostoma dombeyi*. But if we break the connection at k, gill 3, and k[1], gill 2, and at the same time connect the artery between them with the dorsal aorta by a vessel, h (dotted outline), this vessel, h, would be an *efferent branchial artery* of the *usual vertebrate type*. It would receive the blood from the posterior hemi-branch of gill 2, and the anterior hemi-branch of gill 3. I have no doubt that this very relation would be found as a variation, if a large number of specimens of *Bdellostoma forsteri* were examined.

A consideration of the extreme variability of the blood vessels in *Bdellostoma* renders this explanation all the more probable. To give a more adequate idea of the nature and extent of variation, I have made diagrams to show the rela-

tion between the efferent branchials, carotids, and dorsal aorta, as I found it, in five specimens of *Bdellostoma dombeyi*, taken entirely at random.

The variations apparently have no constant relation to the size or sex of the specimen. The number of efferent vessels, of course, varies with the number of gills.



F, G, H, I, J. Diagrams of the efferent branchial arteries and their connections (dorsal view in Bdellostoma dombeyi. Lettering same as in plate figures (q. v.)

As a result of his studies of the blood vessels of Chlamydoselachus, Dr. Ayers (Morphology of the Carotids, Bul. Museum. Comp. Zool., Harvard. Vol. XVII, No. 5, p. 211), reaches the following conclusion: "It is likewise obvious that the carotid vessels cannot strictly be said to arise from, or constitute the remains of, any particular pair of aortic arches, but represents all that is left of the commissural trunk from the most anterior arch of the ancestral form to the most anterior arch of any existing form." Bdellostoma and the Myxinoid type would seem to indicate rather the origin of the carotid arteries from a longitudinal trunk connecting *all* the efferent branchial vessels on each side.

I have not as yet been able to work out fully the distribution and homologies of the blood vessels in the head region. This problem, on account of its difficulty and importance, is reserved for a special paper. I may mention, however, that

the extension forward of the sub-chordal dorsal aorta into the head region as the *vertebralis impar* (*vertebralis impar capitis*, of Müller; *cranial aorta*, of Ayers) is probably a primitive character. This vessel occurs in Chlamydoselachus, as well as the Cyclostomata.

Müller describes a vein in Bdellostoma forsteri which runs from the right pronephros to the posterior cardinal. Only once have I found a similar vessel in Bdellostoma dombeyi. The vein which he describes from the intestine to the common posterior cardinal is also apparently lacking in Bdellostoma dombeyi.

In Petromyzon, as in most Vertebrates, but unlike Bdellostoma, the genital veins open into the posterior cardinals instead of the supra-intestinal vein. The difference in size between the right and left posterior cardinals is only one example of the great asymmetry of the venous system which is so characteristic of Bdellostoma.

The sub-intestinal vein* is the homologue of the large ventral vein in Amphioxus, and the embryonic sub-intestinal vein of higher vertebrates. Judging from the development of Petromyzon (Goette, Entwickelungsgeschichte des Flussneunauges) and other forms, the sub-intestinal vein at first probably supplied the entire intestine, and was continued posteriorly into the caudal vein. The connection of the caudal vein with the posterior cardinals is very probably here, as elsewhere, a secondary arrangement. The reduction in the size and extent of the sub-intestinal vein is correlated with the development of the supra-intestinal vein. It is interesting to note that in Bdellostoma the sub-intestinal vein *does not break up into capillaries in the liver* to form a portal system, although it runs over the surface of, and even *through* the liver tissue. This is evidently an extremely primitive character, for the same relation is found in the early *embryonic* development of the same vessel in Petromyzon (Goette, loc. cit.), and all higher Vertebrates. According to Willey ("Amphioxus and the Ancestry of the Vertebrates") it is yet doubtful whether the sub-intestinal vein in Amphioxus forms a *true* capillary portal system, or merely passes through

*It is a remarkable fact that the presence of this vein in Bdellostoma has apparently been overlooked heretofore by all observers, including Johannes Müller.

a system of small sinuses *outside the liver proper*. In all Vertebrates above Bdellostoma (including Petromyzon), the sub intestinal vein in the adult forms a part of the portal system.

The inferior jugular vein when median and *unpaired*, as in Petromyzon and some of the higher fishes, always empties into the sinus venosus. When *paired*, as in other fishes, it empties into the ductus Cuvieri on each side. Müller recognized that the posterior end of the right anterior cardinal represented the inferior jugular of other forms, but did not describe it as such. According to him (Vergl. Anat. der Myxinoiden, p. 209), the inferior jugular always originates in the hyoid arch and the under side of the operculums. It also commonly receives branches from the muscles of the pharynx, *venæ branchiales inferiores* and *venæ nutritiæ* of the gill arches. Its origin in Myxinoids is dorsal to the ventral aorta, but its course is ventral to it. The large "club-muscle," therefore, has a *double* venous supply. The "retractor" portion is supplied by the inferior jugular vein; the "compressor" portion by the lateral anterior cardinals (jugulars).

The anterior cardinals (or jugulars) of Bdellostoma agree in all essential respects with those in other fishes, excepting the posterior end of the right cardinal. From the probable ancestral form, as represented in Elasmobranchs (viz., symmetrical cardinals, anterior and posterior, flowing into right and left ductus Cuvieri on each side) the present arrangement in Bdellostoma may easily have arose as follows: 1. An anastomosis was formed between the right anterior cardinal and the inferior jugular, near the posterior end of the "club-muscle;" 2. An anastomosis of the posterior end of the anterior cardinal with the portal system; 3. An obliteration of the primitive anterior cardinal vessel *just behind* each of these anastomoses. Furthermore, by a union of the anterior ends of the posterior common cardinals, the blood was diverted from the *right* into the left *ductus* Cuvieri, and the right ductus disappeared entirely. The embryology of the cardinal veins, when worked out, will decide whether this is the true explanation of the present condition in Bdellostoma.

In no other fishes does the blood from the walls of the anterior body region pass into the portal system. It is said

to occur in some Testudinata and Amphibia, however. The portal system of Bdellostoma is also remarkable in being developed chiefly from the supra-intestinal vein, and in having no connection whatever with the sub-intestinal vein.

A well developed portal heart, contractile and supplied with a complete system of valves, so far as I know, occurs nowhere else among Vertebrates (excepting the closely related Myxine?). Contractile veins, however, are not uncommon.

I may sum up my conclusions in regard to the Comparative Anatomy as follows:

PRIMITIVE CHARACTERS IN THE BLOOD-VASCULAR SYSTEM OF BDELLOSTOMA.

1. Persistent pericardio-peritoneal foramen.
2. The simple tubular heart.
3. The large number (up to 14) of functional branchial vessels.
4. The origin of the carotid arteries from a lateral commissural vessel on each side connecting all the efferent branchial arteries.
5. The complete sub-chordal aorta (dorsal aorta) extending forward into the head region.
6. Segmental arrangement of the somatic and renal arteries and veins.
7. Frequent anastomosis between the posterior cardinal veins.
8. Persistent sub-intestinal vein which does not join the portal system.
9. The presence of an inferior jugular vein.
10. The contractility of the portal heart.

CHARACTERS SECONDARILY ACQUIRED.

1. The asymmetry of the venous system.
2. Distribution of branchial vessels to gill slits instead of gill arches.
3 The extension of the portal system into the territory of the right anterior cardinal vein.

4. The connection of the caudal vein with the posterior cardinals.

5. The presence of a well developed valvular portal heart.

EXPLANATION OF LETTERING USED IN FIGURES.

A, auricle.
Al, alimentary canal.
Av, ventral aorta.
Aa, anterior dorsal aorta.
Ap, posterior dorsal aorta.
BA, bulbus aortæ.
Car, right common carotid.
Cal, left common carotid.
H, portal heart.
I, intestine.
L, liver.
La, anterior lobe of the liver.
Lp, posterior lobe of the liver.
M, mesentery.
S, sinus venosus.
T, lobules of testis.
V, ventricle.

aha, anterior hepatic artery.
acl, left anterior cardinal vein.
acr, right anterior cardinal vein.
avv, auriculo-ventricular valves.
av, aortic valves.
af. br, afferent branchial arteries.
ap, anterior portal vein.
cv, cystic vein.
cm, "club-muscle."
clb, "club-muscle" branches.
cap, capillary network.
conv, connecting vessel.
cpa, anterior branch of the common portal.
cpp, posterior branch of the common portal.
coel, coeliac artery.
caud, caudal vessel.
cp, common portal vein.
d, dermal branches.
dcd, deep anterior cardinal.
ep, epithelium of the gill cavity.
ef. br, efferent branchial artery.
ext. car, external carotid artery.
gen, genital branches.
gb, gall cyst.
gpe, external gill passage.
gpi, internal gill passage.
gp, cavity of the gill pouch.
g, gill pouch.
ha, anterior hepatic vein.
hp, posterior hepatic vein.
i, inner (visceral) layer of the pericardium.
ic, "intercostal" vessel.
int. car, internal carotid artery.
jv, inferior jugular vein.
lbr, lateral branch.
mc, mesocardium.
mnr, right mesonephros.
mnl, left mesonephros.
mw, muscular wall of gill pouch.
my, myotomes.
mes, mesenteric arteries.
ntc, notochord.
o, outer (parietal) layer of the pericardium.
ocd, oesophago-cutaneous duct
pcr, right posterior cardinal vein.
pcl, left posterior cardinal vein
pcc, common posterior cardinal
ph, pharyngeal branches.
pnr, right pronephros.
pnl, left pronephros.
ptc, peritoneal cavity.
pcf, pericardio-peritoneal foramen.

pcv, pericardial cavity.
pha, . . posterior hepatic artery.
rbc, . . red blood corpuscles.
r, . . renal branches.
spc, spinal cord.
sub. int, sub-intestinal vein.
scd, . . superficial anterior cardinal.
supr. int, supra-intestinal vein.
sn, . . . "intercostal" nerve.
sgl, . . slime glands.
sav, . . sinu-auricular valves.
s, . somatic vessels.
vv, . . . valves of portal heart.
vg, . . vagus nerve.
x, . . "ductus Botalli,"

In figures IV, V, VI, red line indicates peritoneum; in all other figures—red, arteries; blue, veins; green, portal vessels.

EXPLANATION OF PLATES.

Plate I includes Figures I–IX.

Plate II includes Figures X–XVI.

Plate III includes Figures XVII–XX.

FIGURE I.—Heart of *Bdellostoma dombeyi* (×1). Dorsal view.

A, auricle. V, ventricle. S, sinus venosus. BA, bulbus aortæ. jv, inferior jugular vein. acl, left anterior cardinal. pcc, posterior common cardinal. ha, anterior hepatic vein. hp, posterior hepatic vein.

FIGURE II.—Heart of *Bdellostoma dombeyi* (×1). Ventral view. Lettering same as in Fig. I.

FIGURE III.—Heart of *Bdellostoma dombeyi* (×2). Showing a dorsal view of the ventral half of the auricle and ventricle, the dorsal half having been removed by a horizontal section.

sav, sinu-auricular valves. avv, auriculo-ventricular valves. av, aorta valves. Otherwise as in Fig. I.

FIGURE IV.—Diagram of cross section passing through the mid-abdominal region of *Bdellostoma*.

M, mesentery. A, alimentary canal. ptc, peritoneal cavity.

FIGURE V.—Diagram of cross section passing through the posterior lobe of the liver in *Bdellostoma*.

L, liver.

FIGURE VI.—Diagram of cross section passing through the ventricle and anterior lobe of the liver. Showing the relation of the pericardial cavity to the general peritoneal cavity.

pcf, pericardio-peritoneal foramen. pcv, pericardial cavity. o, outer or parietal layer of the pericardium. i, inner, or visceral pericardial layer. me, mesocardium. V, ventricle. Dotted line, pericardium.

FIGURE VII.—Testis of *Bdellostoma dombeyi* (×2), showing the arterial supply. The genital fold lies on the right side of the mesentery.

wS, mesenteric artery. qs, genital branches. T, lobules of testis. Ap, posterior dorsal aorta.

FIGURES VIII AND XIV.—Highly magnified portions of the smallest branches of a gill leaflet (×450).

cap, capillary wall. ep, epithelium lining gill cavity. rbc, red blood corpusles. con, connective tissue.

FIGURE IX.—Cross section of an injected gill pouch of *Bdellostoma* (×8). Taken perpendicular to the gill axis, about at the center. Camera lucida outline.

mw, muscular wall of gill pouch. gp, cavity of gill, into which gill leaflets project.

FIGURE X. Branchial region of *Bdellostoma dombeyi* (×1½). Ventral view. Body wall opened by a median longitudinal incision, and the lateral flaps folded back. Anterior lobe of the liver removed to expose heart. Arteries colored red. Veins blue.

Av, ventral aorta. af. br, afferent branchial arteries. x, on last afferent branchial artery indicates position of "ductus Botalli." ic, "intercostals" (arteries red, veins blue). S, Sinus venosus. jv, inferior jugular vein. acl, left anterior cardinal vein. supr. int, supra-intestinal vein. A, auricle. V, Ventricle. H, portal heart. Lp, posterior lobe of liver. gb, gall bladder. mnr, mnl, right and left mesonephros. pnr, pnl, right and left pronephros. pcf, pericardio-peritoneal foramen (dotted outline). sgl, slime glands. ocd, oesophago-cutaneous duct. cm, "club-muscle." gpe, spe, external gill passages.

FIGURE XI.—Lateral view of the viscera of *Bdellostoma dombeyi* left side, including ventral view of the left half of the body wall, which has been laid back (×1).

cpa, anterior branch of common portal vein. cpp, posterior branch of common portal vein. Jv, inferior jugular vein. acl, left anterior cardinal. ha, hp, anterior and posterior hepatic veins. cpa, cpp, anterior and posterior branches of common portal vein. ocl, left posterior cardinal. supr. int, supra-intestinal vein. sub. int, sub-intestinal vein. La, Lp, anterior and posterior lobes of the liver. pnl, left pronephros. mnl, left mesonephros. ic, "intercostal" vessels. Otherwise as previously.

FIGURE XII.—Mid abdominal region of *Bdellostoma dombeyi*, showing ventral view of the left side of the body wall, and a lateral view of the intestine and mesentery. The latter have been laid over upon the right side of the body wall, and the mesentery stretched out (×2).

r, renal branches. s, somatic branches (red, arteries; blue, veins). pcl, pcr, posterior cardinal veins, left and right. mes, mesenteric arteries. vg, vagus nerve. sn, "intercostal" nerve. Otherwise as previously.

FIGURE XIII.—Diagram of one half of a section through the gill pouch of *Bdellostoma*, parallel with the axis of the gill. Afferent vessels red. Efferent vessels blue.

af. br, afferent branchial vessel. ef. br, efferent branchial. cap, capillary network.

FIGURE XIV.—See Fig. VIII.

FIGURE XV.—Diagram of a cross section through the body of *Bdellostoma*, just behind the liver.

ntc, notochord. spc, spinal cord. s, somatic branches. ic, "intercostals." d, dermal branches. my, myotomes. Otherwise as previously.

FIGURE XVI.—A ventral view of the dorsal wall of the portal heart of *Bdellostoma dombeyi*, the ventral half having been cut away. (× 2.)

ap, anterior portal vein. supr. int, supra-intestinal vein. cp, common portal vein. vv, valves.

FIGURE XVII.—Diagram of the venous system of *Bdellostoma*, dorsal view (approximately natural size). Portal system, green; general system blue. On the right side, the renal branches of the posterior cardinal are omitted. On the left side, the somatic branches are omitted.

acr, acl, right and left anterior cardinals (or jugulars). dcd, scd, deep and superficial branches of anterior cardinals. s, somatic veins. ph, pharyngeal branches. clb, "club-muscle" branches. jv, inferior jugular vein. S, sinus venosus. pnl, pnr, left and right pronephros. pcc, posterior common cardinal. pcr, pcl, right and left posterior cardinals. ha, hp, anterior and posterior hepatic veins. caud, caudal vein. ap, anterior portal vein. cp, common portal vein. gb, gall bladder. sub. int, sub-intestinal vein. gen, genital veins.

FIGURE XVIII.—Diagram of entire circulatory system in *Bdellostoma* lateral view (approximately natural size). Arterial system, red; general venous system, blue; portal system, green.

Lettering same as Figs. XVII and XX.

FIGURE XIX.—Lateral view of the viscera of the pharyngeal and cardiac regions, including ventral view of the right side of the body wall (× $1\frac{1}{2}$). In this figure the viscera have been laid over upon the left side, in order to show the relation of the blood vessels to the body wall. As a result, the somatic branches of the anterior portal and dorsal aorta in the branchial region are stretched somewhat beyond their normal length.

Aa, anterior dorsal aorta. Ap, posterior dorsal aorta. Car, right common carotid. ph, pharyngeal branches. ap, anterior portal vein. ic, intercostals. supr. int, supra-intestinal vein. cv, cystic vein. sub. int, sub-intestinal vein. pcr, right posterior cardinal. ef. br, efferent branchial vessels. clb, "club-muscle" branches.

Otherwise as previously.

FIGURE XX.—Diagram of the arterial system of *Bdellostoma dombeyi* dorsal view (approximately natural size). The afferent branchial system is omitted. Of the branches of the posterior dorsal aorta, on the right side, the renal branches are omitted. The genital branches should be represented on the right side.

V, vertebralis impar. lbr, lateral branch. ext. car, int. car, external and internal carotid arteries. s, somatic arteries. Car, Cal, right and left common carotid arteries. ef. br, efferent branchials. con. v. connecting vessels. coel, coeliac artery. caud, caudal artery. ren, renal branches. mes, mesenteric arteries.

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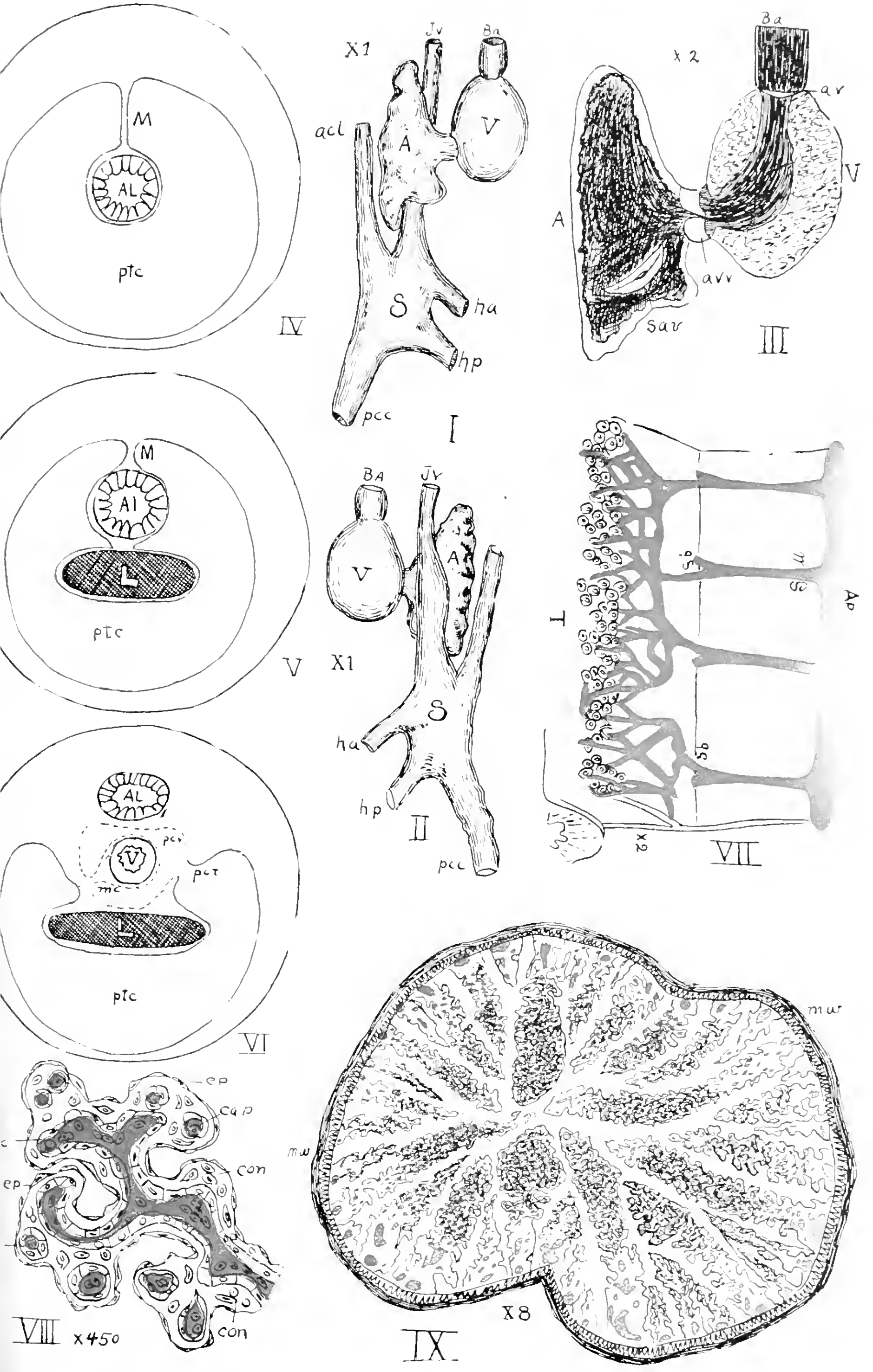

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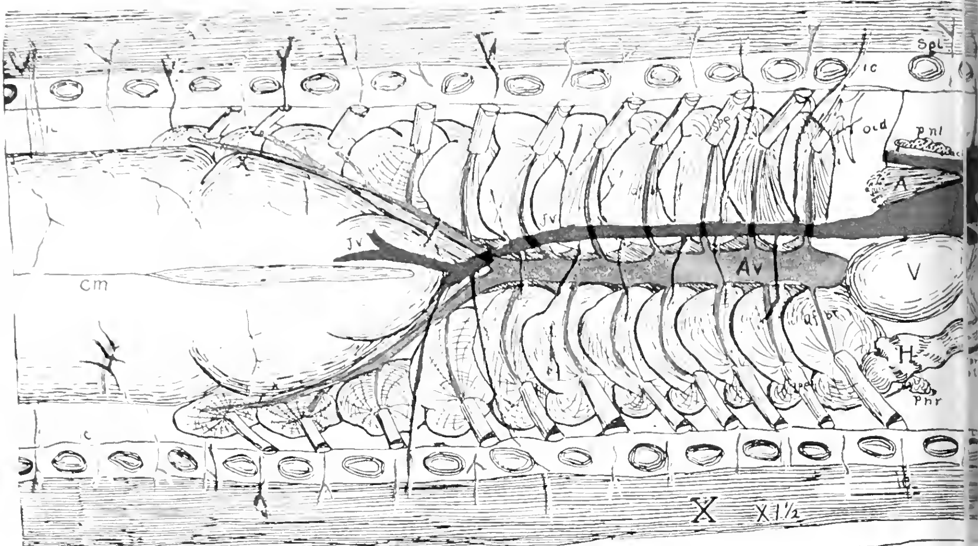

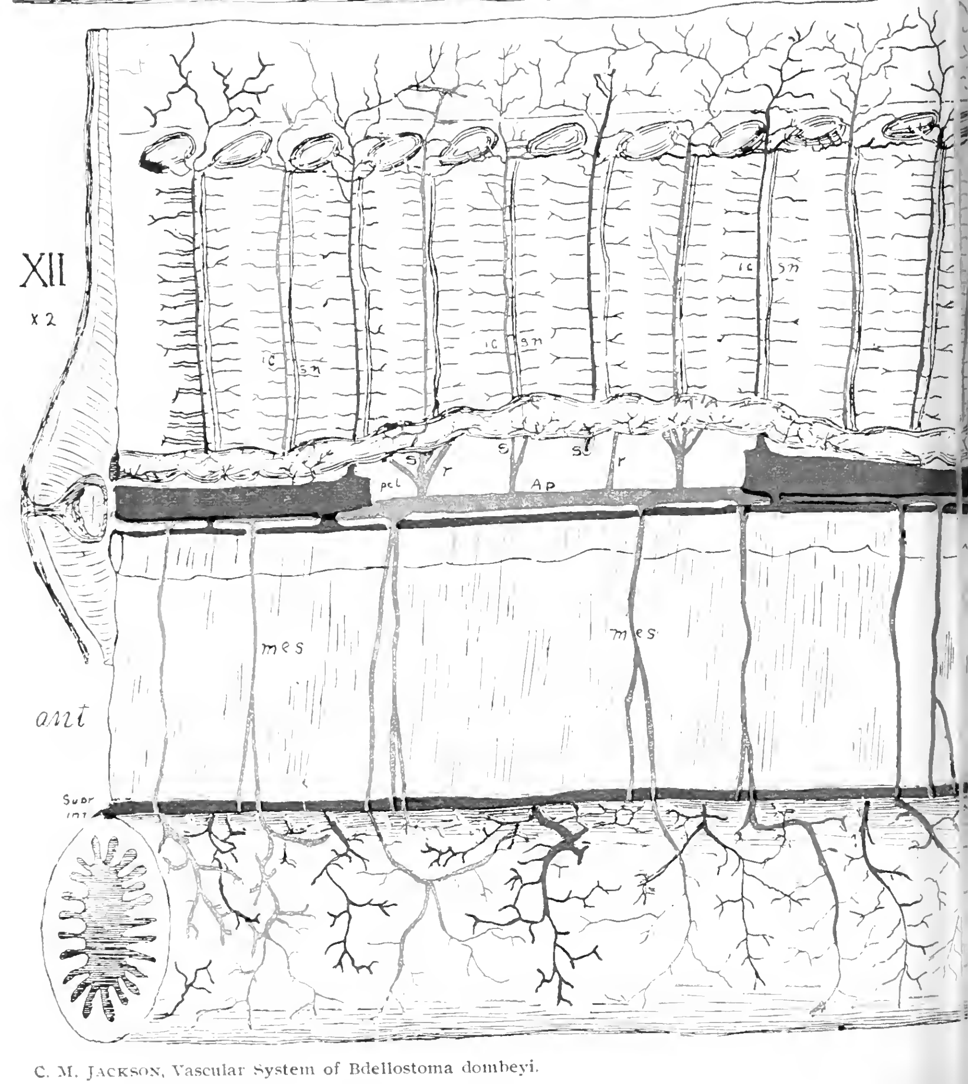

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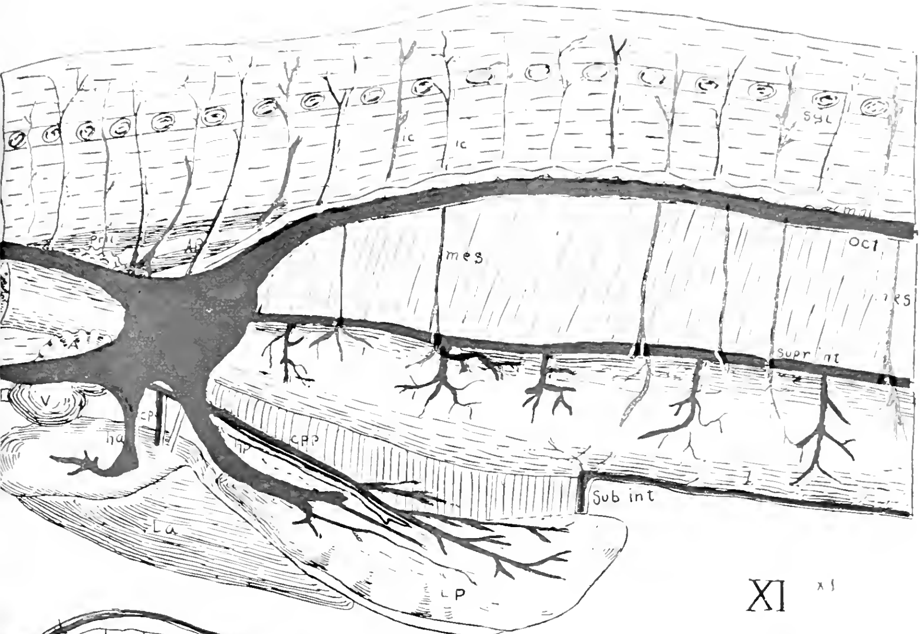

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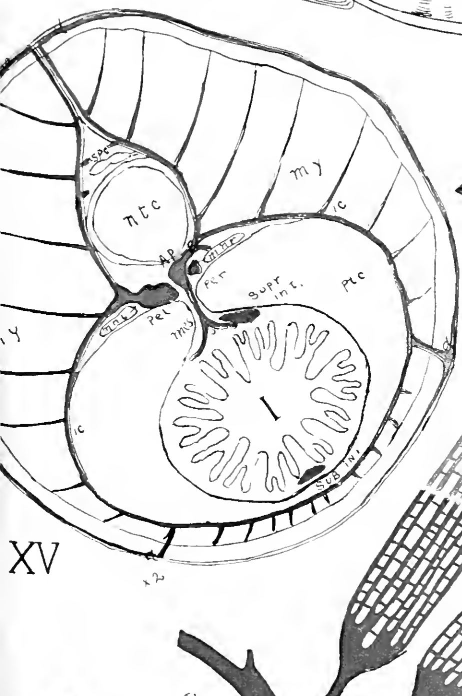

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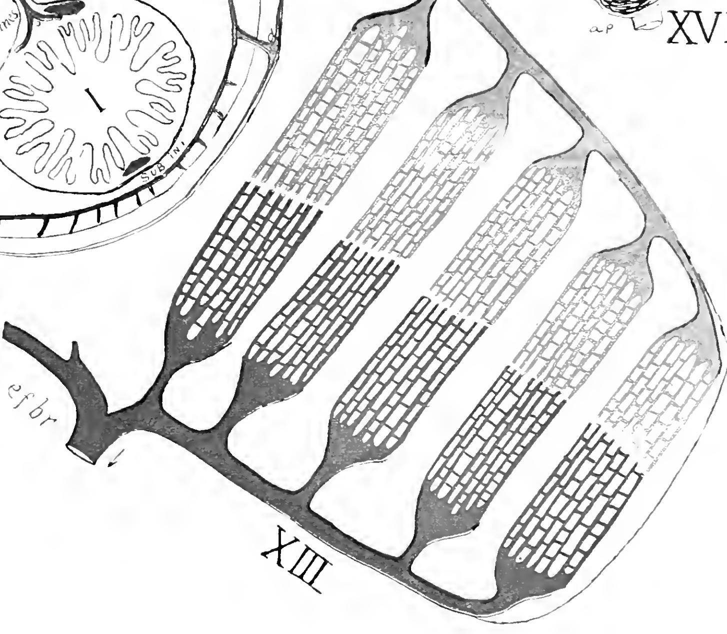

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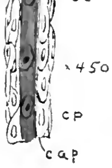

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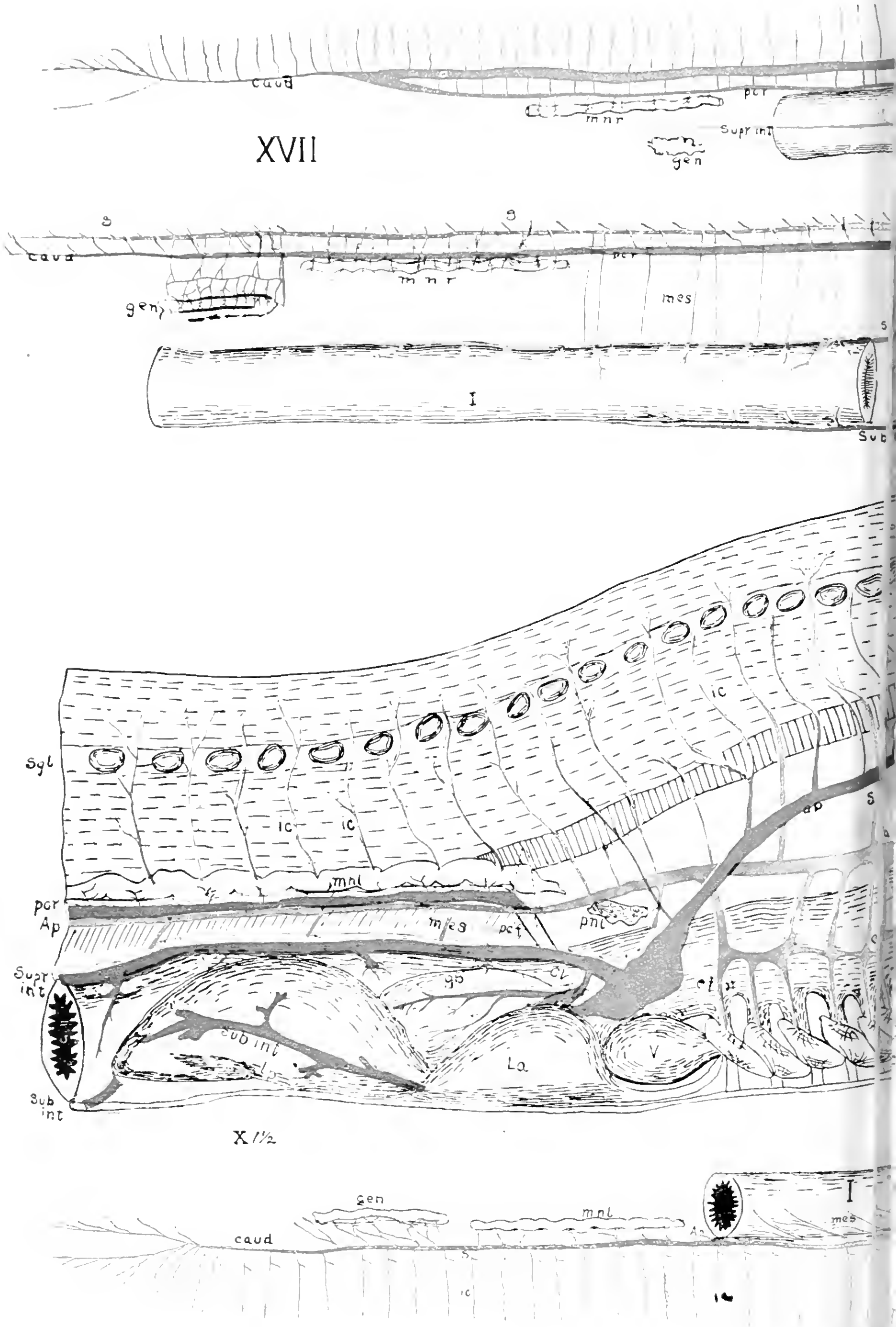
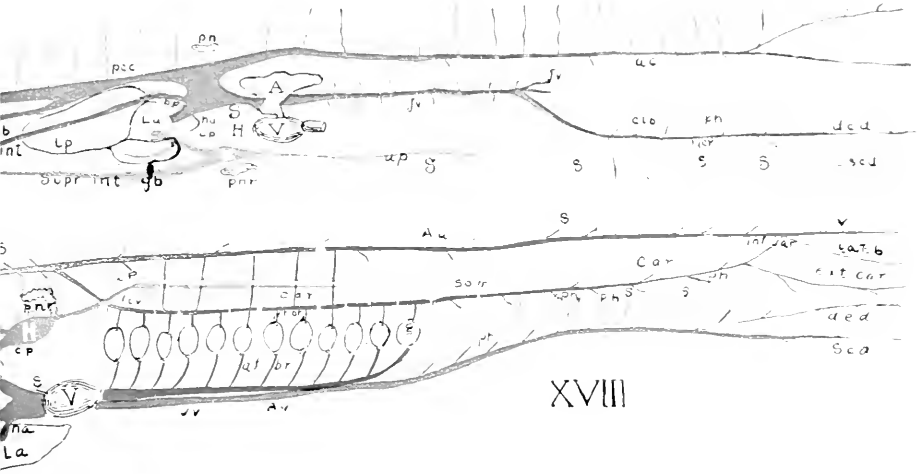
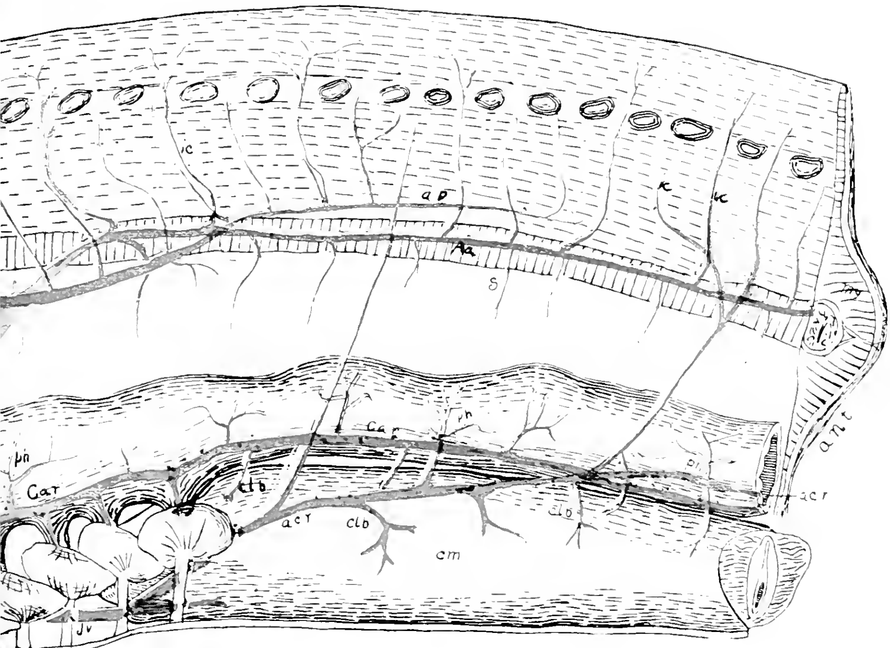
XVII



C. M. Jackson, Vascular System of Bdellostoma dombeyi.

PLATE III.





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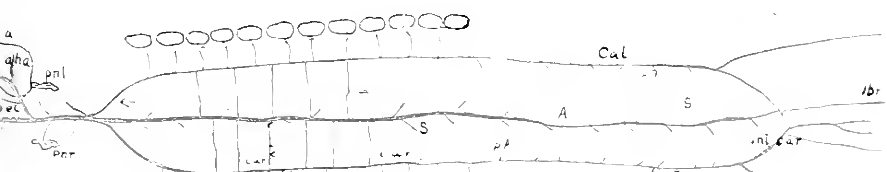

XX

ARTICLE III.—THE GEOLOGY OF CINCINNATI.

BY J. M. NICKLES.

1. TOPOGRAPHY.

The name chosen for the hamlet, settled in 1788, which has become the city of Cincinnati, suggests the reason for its location — Losantiville, L [icking] + os, mouth, + anti, opposite, + ville — the village opposite the mouth of the Licking. The comparatively level tract of land, safely above the flood waters of the Ohio, rendered easy the growth from hamlet to city. Opposite the mouth of the Licking, it stood at the gateway to the northern part of the fertile blue-grass region of Kentucky, at a time when river navigation was the best available mode of transportation. An equally fertile region lay to the north, to which the broad valley of the Millcreek furnished a natural outlet when the locomotive replaced the canoe and flatboat.

This level tract, roughly circular in outline, of an average diameter of three miles, is bounded on three sides by a belt of hills, so-called. On the south the Ohio River separates it from a similar, somewhat smaller, tract lying to the southeast, which is also bordered on three sides by a belt of hills. The two tracts together form a quadrangular area, extending northwest and southeast. The area is really a somewhat basin-shaped depression in a generally rolling country. The so-called hills are the escarpments of the higher land fringing upon the basin. The Kentucky part of the basin is intersected by the Licking River traversing it from the south, dividing it into two parts, now occupied by the cities of Newport and Covington.

Some of the peculiarities of the topography of Cincinnati and vicinity early attracted attention. It was observed that the valley of the Little Miami River for several miles above its confluence with the Ohio is wider than that of the Ohio from this point down; for many miles below the mouth of the Millcreek, the valley of the Ohio is very narrow, scarcely more than a trough; the valley of the Licking is quite wide for several miles up from its mouth; the valley of the Mill-

creek, extending north for several miles, then northeast and again north, seems altogether too wide for the insignificant stream now flowing through it; from the valley of the Little Miami, between Red Bank and Plainville, a broad belt of depressed land extends northwestwardly until it enters the Millcreek valley, near St. Bernard or Ludlow Grove.

The second geological survey of Ohio, 1869-1875, began the work of accumulating the data to explain this topography. Attention was called to the broad valley of the Millcreek extending from Hamilton to Clifton, there dividing, the westerly branch still occupied by the Millcreek, the other extending east and southeast to the Little Miami valley, and it was thought that the Big Miami may have taken this course to reach the Ohio.* The depth to the solid rock in the Millcreek valley as shown by a well in Cumminsville,† 151 feet below the surface, or 60 feet below low-water mark of the Ohio River is noted, and its bearing upon elevational movements commented upon.

The first connected attempt to explain the peculiarities of Cincinnati's topography was a paper by Prof. Joseph F. James.‡ He considered that a barrier extended across the Ohio from the Kentucky shore to the south end of the range of hills west of the Millcreek, evidence of the barrier being found in the beds exposed in the bank of the Ohio near Ludlow and in McCullum's Riffle, a conspicuous bar in low water a few miles below the city; that the Ohio divided into two branches, one flowing northwest from the Little Miami valley between Red Bank and Plainville, the other south of and around the "Cincinnati Island," the higher land now occupied by the suburbs, Walnut Hills, Avondale, and Clifton, the two branches uniting near Ludlow Grove, thence together flowing to Hamilton, thence southwest through the valley of the Big Miami; the blocking of this northward channel in glacial times compelled the Ohio to cut across the barrier at Sedamsville.

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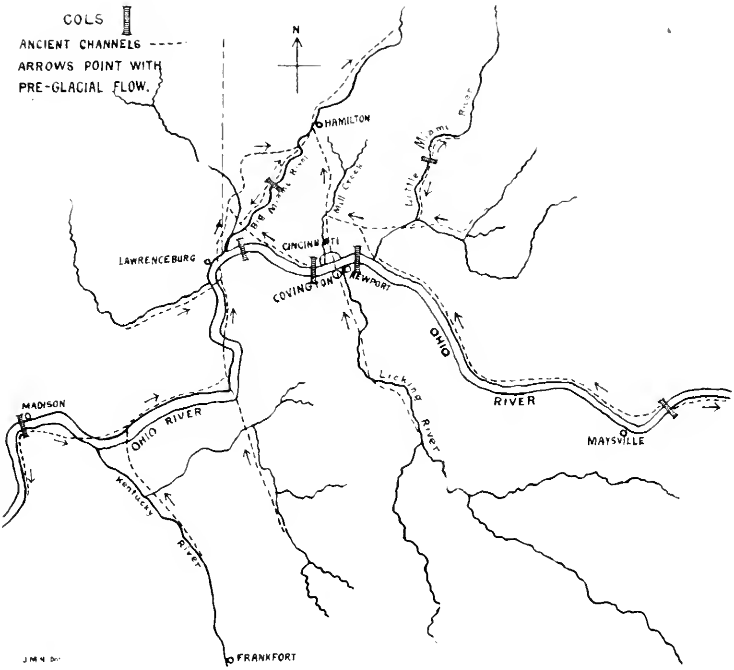
*Orton, Edward. Geol Ohio, I. p. 420.

†Ibid., p. 433.

‡The Geology of Cincinnati. Jour. Cincinnati Soc. Nat. Hist., IX, 1886, pp. 20-31, 130-141.

Within the past few years the researches of glacialists have shown that the present drainage system of the northern half of the Ohio drainage basin is very different from what it was before the advent of the Ice Age. The earlier drainage was



shaped by the sequence of geological events in paleozoic ages. This natural drainage, so to speak, was reformed by the advance of the ice sheet from the north, carrying with it a vast mass of debris from the lands corroded by it. The ice sheet and its debris, damming up ancient channels, backed the rivers up into lakes until the latter, breaking over the lower parts or cols of the bounding ridges, fashioned for the rivers new channels. The pre-glacial drainage of southwestern Ohio has been specially investigated by Mr. Gerard Fowke.* He considers that a col extended from the high-

*Bull. Sci. Lab. Denison Univ., XI, 1899, pp. 1–10; Ohio State Acad. Sci., Special Papers, No. 3. 1900, pp. 68–75.

land east of Newport and Bellevue, Kentucky, north to East Walnut Hills, by which the waters of Old Limestone, which has furnished part of the course of the modern Ohio, were deflected north through the lower part of the valley of the Little Miami, which explains the great width of that valley. At Red Bank this ancient stream turned northwest and through the valley of the Millcreek found its way to Hamilton, Ohio, and thence to the great pre-glacial river, which has been named the Great Kanawha. At Hamilton this river was joined by the Kentucky River which flowed northeastward from its present point of confluence with the Ohio through what is now part of the Ohio's course and then northwardly and eastwardly. The Licking River, flowing northwardly through the lower part of the Millcreek valley, joined Old Limestone at Ludlow Grove. Among the changes made during or at the close of the Ice Age was the breaking down of the cols at East Walnut Hills and Sedamsville, thus giving the Ohio its present course.

2. GEOLOGY.

a. Historical.

At the time of its first settlement, the slopes of the "hills" about the city were clad in green and generally wooded. The ravines here and there laid bare the strata which form the framework of the hills. As the settlement grew quarries were opened in the slopes. Thus the region surrounding Cincinnati early became noted as affording very fine exposures of Lower Silurian strata, which yielded a very large number in great variety of finely preserved fossils.

In the year 1836 a geological survey of the State of Ohio was organized, but after two annual reports its work was brought to an untimely end by the financial troubles of 1837. The southwestern part of the State was entrusted to Dr. John Locke. In the second annual report* he gave a brief account of the "Blue Limestone," as the formation in the southwestern corner of Ohio was called, and the overlying "Cliff Limestone." Plate 2, facing p. 210, gives a section

*Second Ann. Rep. Geol. Surv. State of Ohio, Columbus, 1838, pp. 205–211.

from "Keys's Hill" across the Ohio River to "Botany Hill" in Kentucky. It is interesting to note that the main divisions of the Cincinnati strata are well indicated. The Blue Limestone was considered to have a thickness of at least 1,000 feet. The general arrangement of the strata of Ohio was fairly well understood, and the Cincinnati uplift as the axis upon whose slopes later formations were successively laid down was well made out.

As early as 1829 the Blue Limestone was correlated by Lardner Vanuxem* with the rocks occurring at Trenton Falls, New York, from their fossil contents. This determination was generally accepted for many years.

In the following decade the magnificent work of the New York Geological Survey, by making known and naming the successive Paleozoic formations of the State of New York, laid the groundwork for American geological science. Two questions the survey left unsettled; one produced the celebrated Taconic controversy, the other was the real meaning and scope of the term Hudson River group. Dr. W. W. Mather,† in charge of the First Geological District, proposed the name Hudson River slate group, which he afterward‡ amended to Hudson River group, for the lowest rocks in his district, exposed along the Hudson River. The rocks were generally unfossiliferous, and more or less altered after their deposition. The term, while accepted by the Geological Board of the State, seems not to have received entire approval or been clearly understood. Emmons§ continued to use the term Lorraine Shales for a formation, finely shown in the gorges of Jefferson County, New York, occupying supposedly the same geological horizon.

Gradually doubt arose as to Vanuxem's correlation of the Blue Limestone with the Trenton of New York. Prof. James Hall,‖ in 1842, considered a green shale occurring at Newport, Kentucky, equivalent to the Utica shale of New York, and the rock below it, seen only during low water in

*Amer. Jour. Sci., XVI, 1829, p. 256.

† Fourth Ann. Rep. Geol. Survey New York, 1840, p. 212.

‡ Geol. New York, Geol. First Geol. District, 1843, p. 367.

§ Geol. New York, Part II, Second Geol. District, 1842, p. 119.

‖ Amer. Jour. Sci., XLII, 1842, p. 61.

the Ohio River, as probably the equivalent of the Trenton. This early correct determination seems to have been lost sight of or disbelieved. A year later Prof. Hall* referred the main mass of strata occurring at Cincinnati to the Hudson River group. Some years later, 1862, Prof. Hall,† influenced by the studies of Sir William Logan, of the Canadian Geological survey, concluded that the strata in the valley of the Hudson referred to the Hudson River group were older geologically than those referred to the same group farther west in New York and in the Mississippi valley and proposed to drop the term. But in 1877‡ he concluded that he had been in error in dropping the term.

In 1865 Meek and Worthen,§ then at work upon the geology of Illinois, influenced by Hall's discarding the term Hudson River group and the uncertainty prevailing as to just what this term stood for, proposed the term "Cincinnati group" for the blue limestone strata of Cincinnati and vicinity and their equivalents elsewhere.

The second geological survey of Ohio began in 1869 a thorough examination of the geological structure of the State. The term "Cincinnati group" was adopted for the "Blue Limestone series" of the first survey. Partly for the reasons given by Meek and Worthen, but more especially because he considered that the blue limestone formed a homogeneous and indivisible whole in which there was a hopeless and inextricable confusion of Hudson and Trenton species, Dr. J. S. Newberry,|| the chief of the survey, felt constrained to adopt their name. But as to this intermingling of Hudson and Trenton fossils, Dr. Newberry was mistaken; this supposed intermingling is due to the faulty identification of fossils incident to a time when paleontological science had not reached its present refinement and exactness.

This conclusion of the geological survey seems not to have been acceptable in all quarters. While Mr. S. A. Miller at

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* Trans. Amer. Assoc. Geol. and Nat., 1843, pp. 267-293.

† Rep. Geol. Surv. Wisconsin, I, 1862, p. 47 (foot note) and p. 443.

‡ Note upon the history and value of the term Hudson River group in American geological nomenclature. Proc. Amer. Assoc. Adv Sci., XXVI, 1877, pp. 259-265.

§ Proc. Acad. Nat. Sci., Philadelphia, 1865, p. 155, and Geol. Illinois, I, 1866, p. 136.

|| Geol. Surv. Ohio, I, 1873, p. 117.

first* seems to have accepted the name, he later** calls it a synonym for the Hudson River group. In 1879 a committee of ten of the Cincinnati Society of Natural History, with Mr. Miller as chairman, submitted to that body a report† in which it was held that the strata in the river bank in the First Ward of Cincinnati (Fulton) and those in Taylor's Creek, east of Newport, containing *Triarthrus becki* are to be considered of Utica age; all strata above these indicate the Hudson River group of New York.

This summary rejection of the name Cincinnati group did not have the indorsement of all the Cincinnati geologists; Mr. U. P. James†† objected to thus summarily disposing of a valid and well-established name. As pointed out by Mr. Joseph F. James,‡ some of the members of the committee continued to use the term "Cincinnati group."

At a later date, 1888, Dr. Orton,‡‡ then State Geologist, proposed to discontinue the use of the term Cincinnati group. The three hundred feet of shale, disclosed by drilling at Findlay, Ohio, as overlying the Trenton, which he identified as the equivalent of the Utica shale of New York, led him to adopt the term Hudson River group for the shales overlying these three hundred feet of Utica shales.

In an admirable review of the Hudson River question in the light of his own investigations, Mr. Charles D. Walcott§ favored retaining the term Hudson (dropping the "River") for the series of strata between the Trenton limestone and the superjacent Upper Silurian rocks, Hudson being made the name of the terrane to include the Hudson River shales and grits, Utica shales, Frankfort shales, Lorraine shale and sandstone, Salmon River sandstone and shale, Cincinnati shale and limestone, Nashville shale, and Maquoketa shale.

The question of the name may now be considered to have been practically quieted. Winchell and Ulrich|| in their cor-

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* Cincinnati Quar. Jour. Sci., I, 1874, pp. 63-4.

** Jour. Cincinnati Soc. Nat. Hist., IV, 1881, p. 268.

† Ibid., I, 1879, pp. 193-4.

†† The Paleontologist, No. 4, 1879, pp. 27, 28.

‡ Jour. Cincinnati Soc. Nat. Hist., XIV, 1891, p. 98.

‡‡ Geol. Surv. Ohio, VI, 1888, p. 9.

§ Bull. Geol. Soc. America, I, 1890, pp. 335-356.

|| Geol. Minnesota, III, Part II, 1897, p. ci

relation of Lower Silurian strata use the title "The Hudson River or Cincinnati Period," but express their preference for the second term, the other having been placed first because used in previous volumes issued by the Minnesota survey. Clarke and Schuchert,* in giving a revised nomenclature of the New York series of geological formations, use the term Cincinnatian—with the divisions Utica, Lorraine and Richmond (Ohio and Indiana)— omitting the term Hudson River altogether. Rudolf Ruedeman† has shown by an exhaustive study of the Hudson River beds near Albany, New York, that a fault, not hitherto detected, separates the strata of the Hudson River valley from those of the Mohawk valley, and that the fauna of the Hudson River beds, mainly graptolites, proves to belong to a terrane low in the Trenton, hence the name Hudson River is a misnomer

Subdivisions.

1. River Quarry Beds—(Point Pleasant Beds.)

The Cincinnati anticline, or as Prof. Orton has since wisely renamed it, the Cincinnati uplift, is exhaustively treated by Dr. J. S. Newberry in volume I, pp. 93–111, of the Reports of the Ohio Geological Survey, to which the reader is referred for full particulars.

In the division of work of the second geological survey of Ohio Prof. Edward Orton was assigned the geology of the southwestern part of the State. In his report‡ he divides the Cincinnati group into the Point Pleasant beds, exposed in the north bank of the Ohio River in Clermont County, about twenty-five miles east of Cincinnati, to which he assigned a thickness of fifty feet; the Cincinnati beds proper, extending from low-water mark of the Ohio River to the highest stratum found in the Cincinnati hills, comprising 450 feet; and the Lebanon division, embracing about 300 feet of strata, lying between the highest stratum of the Cincinnati hills and the lowermost beds of unmistakable Upper Silurian age. The Cincinnati beds proper he divided into the river

* Science, n. s., X, 1899, pp. 874–878.

† Bull. New York State Mus., VIII, No. 42, 1900, pp. 564–568.

‡ Geol. Surv. Ohio, I, 1873, pp. 365–449.

quarry beds, fifty feet thick; the middle or Eden shales, 250 feet thick; and the Hill quarry beds, 150 feet thick.

This division was criticised by Mr. S. A. Miller,* who could not see that the Point Pleasant beds were any different from Cincinnati beds, though probably somewhat lower, and that the divisions of the Cincinnati beds proper were useless, and with no facts to warrant any such division. The committee of the Cincinnati Society of Natural History on nomenclature** reported that the Trenton is not exposed at Cincinnati, nor at any point west of the city, "but we think it may be represented in the banks of the Ohio River a few miles east of the city."

Thus the age of the Point Pleasant beds proved a matter of dispute. Mr. W. M. Linney,† of the Kentucky Geological Survey, thought the Trenton included "doubtless, the building stones quarried at Point Pleasant, on the Ohio River above Cincinnati." In a paper on the correlation of the Lower Silurian horizons, Mr. E. O. Ulrich†† seems to have regarded the Point Pleasant beds as of the same age as the strata outcropping in the river bank in West Covington, which he includes in his "Beds XI;" earlier in the same paper‡ these beds are referred to "Beds X" which are exposed at Lexington, Kentucky. Throughout this paper, which was left unfinished, the author studiously avoids indicating the age of the various beds, no doubt intending to give this in the later discussion.

In Volume VI of the Reports of the Ohio Geological Survey, dealing mainly with petroleum and natural gas, and the geological facts brought to light by the drill, the Point Pleasant beds are recognized for the first time by the survey as Trenton.§ The equivalent strata‖ at Cincinnati were considered to be 300 feet below the surface. How such a dip in twenty odd miles is made to agree with the almost horizontal

*Cincinnati Enquirer, August 7, 1873.

**Jour. Cin. Soc. Nat. Hist., I. 1879, pp. 193–4;

†Notes on the Rocks of Central Kentucky. Geol. Surv. Kentucky. J. R. Proctor, Director, 1882, p. 6.

††Amer. Geologist, I, 1888, p. 307.

‡Ibid., p. 181.

§Geol. Surv. Ohio, VI, 1888, p. 5.

‖Ibid., p. 6.

character of the strata of the Cincinnati uplift as previously worked out by Prof. Orton* is not explained.

In 1890 Prof. Joseph F. James studied the Point Pleasant beds and gave a detailed columnar section.** He reached the conclusion that the rocks in the river bank from West Covington to Ludlow are identical with the Point Pleasant beds, in which conclusion he was correct; and that neither belongs to the Trenton, in which he was incorrect, as these strata are unquestionably of Trenton age. In 1897 Winchell and Ulrich, in their correlation of Silurian horizons,† referred to the West Covington river beds as belonging to the Trenton group.

II. Eden Shales—(Utica Group.)

The earliest identification of Utica at Cincinnati was by Prof. James Hall in 1842 (see *ante* p. 53). The Committee on Geological Nomenclature of the Cincinnati Society of Natural History (see *ante* p. 55) also considered these strata, at least the lower part of them, as Utica. Later these strata seem to have given trouble. Ulrich in his paper on the correlation of the Lower Silurian Horizons‡ says: "Several feet of shales that are *supposed* to represent the portion of the section immediately below that mentioned in the preceding paragraph [the West Covington or Ludlow strata] are exposed under the bank of the river in the First Ward of Cincinnati." In reality these shales overlie the Trenton rocks of West Covington. This error has caused some of the fossils which properly belong in column XIb to be placed in column XIa§. In this same paper Ulrich|| identifies his "Beds XIb," to which he gives a thickness of 225 feet, with the black shales 300 feet thick, immediately overlying the Trenton in the Findlay wells, which he agreed with Prof. Orton in correlating with the Utica shale of New York. There can be no question as to the correctness of this identification.

* Geol. Ohio, I, 1873, p. 412.
** Jour. Cincinnati Soc. Nat. Hist., XIV, 1891, pp. 93-104.
† Geol. Minnesota, III. Part II, 1897, p. xcviii.
‡ American Geologist, I, 1888, p. 309.
§ Amer. Geologist, I, 1888, pp. 183-190. See also p. 312.
|| Ibid., p. 315.

In Volume VI of the Reports of the Geological Survey of Ohio, Prof. Orton* shows that the black Utica slate or shale, 300 feet thick under cover at Findlay, gradually thins toward the south and is finally lost by overlap of the Hudson River shale, and considers, that if any part of the series exposed at Cincinnati and vicinity belongs to the Utica, it is the fifty to 100 feet of greenish blue shale overlying the Point Pleasant or Trenton limestone, but thinks that, on the whole, the evidence is against their having been formed contemporaneously with the black Utica shale of northern Ohio.

III. Hill Quarry Beds — (Lorraine Group.)

To that division of the Cincinnati beds proper, that overlies the Eden or middle shales, Prof. Orton gave the name Hill Quarry beds with a thickness of 150 feet. The layer at the top of the highest hills in the city of Cincinnati, which contains the large *Orthis* (*Platystrophia*) *lynx*, and which was traced into adjoining counties on the east and north, was considered to mark the boundary between this division and the next succeeding, to which he gave the name Lebanon beds.

The name Lorraine shales was given by Ebenezer Emmons† to a series of shales finely exposed in the gorges of Lorraine and Rodman in Jefferson County, New York, overlying the Utica slate, and consisting of thin beds of gray sandstone, alternating with fine argillaceous slates of a greenish color, even bedded, and in the upper part highly fossiliferous. He did not correlate it with the Hudson River group.

No attempt was made to apply the name to strata in the Mississippi valley, until it became quite evident that the term Hudson River group was a misnomer. In their correlation of strata Winchell and Ulrich‡ propose to use the name Lorraine group for the 200 feet of strata at Cincinnati overlying the shale beds which they refer to the Utica.§ The term has also been used by Mr. Charles Schuchert in his "Synopsis of American Fossil Brachiopoda,|| but he has made it include the strata to which the term Richmond group is now applied.

*Geol. Ohio, VI, 1888, p. 8.

†Geol. New York, Part II, Survey of the Second Geol. District, 1842, p. 119.

‡Geol. Minnesota, III, Part II, 1897, p cii

§Ibid., p. cii,

|| Bull. U. S. Geol. Survey, No. 87, 1897.

IV. Lebanon Beds — Richmond Group.

The upper division of the Cincinnati series was named by Prof. Orton the Lebanon beds, with a thickness of nearly 300 feet. For this name Winchell and Ulrich* have substituted the name Richmond group, from Richmond, Indiana, where this division is finely exposed, holding that the name Lebanon is objectionable, as it was previously applied by Safford to Tennessee rocks belonging to the Trenton. Another, perhaps more valid objection, is the fact that all the strata in the immediate vicinity of Lebanon, Ohio, belong to the Lorraine group. The Richmond is not present in the New York system, unless a sandstone formation overlying the Lorraine shales represents it.

b. Stratigraphy.

THE TRENTON PERIOD AT CINCINNATI.

Point Pleasant Beds.

The principal exposures of these beds in the vicinity of Cincinnati are the outcrop in the south bank of the Ohio River, extending from West Covington one mile west to Ludlow, which presents the most satisfactory exposure for study; an outcrop at the mouth of the Licking River and outcrops at various points in its banks for several miles up that stream; outcrops in the south bank of the Ohio River in Campbell County, Kentucky, from Fort Thomas up the river for a number of miles; and in the north bank of the Ohio in Clermont County, Ohio, particularly in the vicinity of Point Pleasant.

At Point Pleasant and at several small streams between Point Pleasant and New Richmond, quarries have been opened in the Trenton, though at present none are worked. The Trenton is much thicker here than has been heretofore reported; the highest stratum of the Trenton is about 130 feet above low-water mark of the Ohio. The lowest 50 or 60 feet are rarely shown, but appear to differ but little lithologically from the strata higher up, which have been

*Geol. Minnesota, III, Part II, 1897, p. ciii.

quarried. From 40 to 50 feet are shown in the quarries, leaving some 30 feet more before reaching the top of the Trenton.

An average section of the exposure in West Covington is as follows:

No. 3.	Crinoidal layer, ...	1 – 2 feet.
No. 2.	Limestone layers with some shale, ...	27 feet.
No. 1.	Layers consisting mainly of bluish shale,	17 feet.
	Concealed to low-water mark, ...	4 feet.
	Total, ...	50 feet.

No. 3. This layer marks the top of the Trenton formation about Cincinnati. Utica shale rests upon its upper surface with more or less unconformity by erosion. It is composed of comminuted fragments, mainly of separated joints of crinoid stems, indiscriminately thrown together and more or less firmly cemented, the arrangement giving evidence of current formation and perturbed changing conditions. The fact that the limestones beneath this layer give place to the shale above it indicates that a very great change had come in geographical conditions. This layer, No. 3, contains several forms restricted to it, most noticeable being the huge *Escharopora ponderosa* (Ulrich), and the *Dendrocrinus dyeri* Meek.

No. 2. This division consists mainly of even-bedded, close-textured, dove-colored limestones, varying from two to six inches or somewhat more in thickness. Some of the layers are semi-crystalline, some so close-textured that all traces of fossils have disappeared, some are a mass of fossils. This last is especially true of the "gastropod layers," in the lower part of this division. On the whole fossils are abundant, but good specimens are not to be easily had. The shale partings between the limestone layers, varying from one to eight inches in thickness are usually barren, but are sometimes very rich in fossils, especially minute ostracoda.

No. 1. These shales are usually bluish and friable, and commonly entirely destitute of fossils. This shale is a variable feature; in some places it is much reduced in thickness, then the limestone division is increased in thickness.

About ten feet below the crinoidal layer (No. 3), a "wavy limestone" layer makes its appearance. No satisfactory explanation has yet been given of the mode of formation of these undulated limestones, which occur also in the Utica and Richmond groups. It is only the upper surface which is waved.

A large and varied fauna has been made known from these Trenton beds, but it is the result of many years' careful searching by many collectors. The meagre results of a day's collecting will no doubt prove disappointing to those visiting the "low river quarries" for the first time. The commonest and most characteristic fossil is the bryozoan *Eridotrypa briareus* (Nicholson). Below is given a list of fossils recorded as occurring in the Point Pleasant beds.*

COELENTERATA.

Tetradium fibratum Safford.

ECHINODERMATA.

Dendrocrinus dyeri (Meek).
" navigiolus Miller.
Iocrinus subcrassus Meek and Worthen, variety.
Lichenocrinus pattersoni Miller.
Merocrinus typus Walcott.
Palæaster dubius Miller and Dyer.

*The lists given in this paper are by no means exhaustive. After all the painstaking collecting of many years new forms are continually being brought to light. Harper and Bassler's Catalogue of the Fossils occurring in the vicinity of Cincinnati, 1896, which gives the ranges of fossils, has been used as a basis in assigning the fossils to the various subdivisions given in this paper. In revising the lists and making corrections where needed, the writer has had the generous help of his friends, Messrs. R. S. Bassler and E. O. Ulrich. The exact horizons at which some of the rare forms have been found are not known; hence these forms may have been assigned to wrong beds. Some species that are given as restricted to certain beds may prove to have a longer range, others may be found to be more restricted than here indicated.

It is unfortunate that there is at Cincinnati no good representative collection of her fossils. The fine collections made in earlier years, which can probably never be duplicated, have been taken away. The magnificent collection of C. B. Dyer, which contained the choicest gatherings of a number of collectors for a long period of years, comprising a very large number of the rare forms, some of them unique, is now the property of the Museum of Comparative Zoölogy, at Harvard University, in Cambridge, Massachusetts. The fine collection of I. H. Harris, of Waynesville, Ohio, which was especially rich in rare Richmond group forms, is now the property of the U. S. National Museum. The latter institution has also recently come into possession of the unrivaled collection of E. O. Ulrich, which contains a very large number of types of bryozoa, gastropoda, lamellibranchs and of other classes. The collection of U. P. James, very rich in bryozoa and also containing many types, has gone to the University of Chicago. The paleontological collection of the Cincinnati Society of Natural History consists mainly of odds and ends which have come to it piecemeal.

BRYOZOA.

Aspidopora calycula (James).
Eridotrypa briareus (Nicholson) (c)*
Eridotrypa mutabilis (Ulrich) (c)
Peronopora sp.
Escharopora ponderosa (Ulrich).

BRACHIOPODA.

Leptobolus lepis Hall.
Lingula covingtonensis Hall and Whitfield.
Lingula modesta Ulrich.
" procteri Ulrich.
" whitfieldi Ulrich.
Lingulops norwoodi (James).
Plectambonites sericeus (Sowerby)
Rafinesquina alternata Conrad-Emmons, variety. (c)
Schizocrania schucherti Hall and Clarke.
Trematis fragilis Ulrich.
Zygospira recurvirostris Hall.

PELECYPODA.

Byssonychia byrnesi Ulrich.
Clionychia subundata Ulrich.
Lyrodesma subplanum Ulrich.
" poststriatum Emmons.
Modiolopsis oblonga Ulrich.
Pyrenomœus subcuneatus Ulrich.
Whiteavesia cancellata (Walcott).
Whiteavesia cincinnatiensis (Hall and Whitfield). (c)
Whiteavesia kentonensis (Ulrich).
" modioliformis (Meek and Worthen).
Whiteavesia pulchella Ulrich.

GASTROPODA.

Archinacella patelliformis (Hall).
Bucania nana Ulrich.
Carinaropsis explanata Ulrich.
Conularia quadrata Walcott.
" trentonensis Hall.
Cyclonema varicosum Hall.
Cyclora depressa Ulrich.
" minuta Hall.
" parvula (Hall).
Cyrtolites parvus Ulrich.
" retrorsus Ulrich.
Cyrtolitina nitidula Ulrich.
Fusispira sulcata Ulrich.
Lophospira abnormis Ulrich.
" oweni Ulrich and Scofield.
Protowarthia cancellata (Hall). (c
Tetranota bidorsata (Hall).

CEPHALOPODA.

Cameroceras proteiforme (Hall), variety.
Orthoceras albersi Miller.
" junceum Hall.
Orthoceras ludlowense Miller and Faber.
Trocholites ammonius Conrad.

VERMES.

Cornulites sp.
Serpulites dissolutus Billings.

* The (c) following the name of a species indicates that it is a common fossil.

CRUSTACEA.

Asaphus gigas DeKay.
" maximus Locke.
Calymmene callicephala Green.
Ceratopsis intermedia Ulrich.
Gerasaphes ulrichanus Clarke.
Lepidocoleus jamesi (Hall and Whitfield).
Primitia perminima Ulrich.
Primitiella unicornis Ulrich.
Trinucleus concentricus Eaton.
Ulrichia bivertex Ulrich.

POSITION UNCERTAIN.

Bythotrephis gracilis Hall.
" gracilis-crassa Hall.
Lockeia siliquaria James.
Solenopora compacta (Billings).

THE CINCINNATI PERIOD.

The formation comprising the surface strata of southwestern Ohio, southeastern Indiana and northern Kentucky, early known as the Blue Limestone, afterwards as the Cincinnati Group, has now come to be considered one of the major divisions of the Ordovician or Lower Silurian Era, with the title Cincinnati Period. As a whole it consists of clayey or marly, bluish or yellowish shales alternating with even-bedded, rather thin layers of limestone, the latter usually bluish and abundant enough to justify the early designation of Blue Limestone Formation. Occasionally there are layers containing considerable grit. Towards the close of the period considerable beds of sandy material were deposited in some places; e. g., the Cumberland sandstone of Kentucky.

While formerly considered a homogeneous whole, even with the Trenton strata of West Covington included, the Cincinnati period is now known to be easily separable into three divisions important enough to justify the application of the term group. These divisions in descending order are:

3. Richmond group,	between 200 and 300 feet thick.
2. Lorraine group,	310 feet thick.
1. Utica group,	260 feet thick.
Total,	770–870 feet.

There is considerable variation in the different groups in the proportions of limestone and shale. Shale greatly predominates in the Utica, but from the lower beds of the Lorraine on, the proportion of limestone gradually increases. This shows that there was a gradual change from more or less turbulent conditions prevailing at the close of the Trenton to the time of the Lower Richmond, when quiet seas permitted the accumulation of the materials for closely succeeding beds of limestone. As the period came to a close, there came anew turbulent conditions. The fauna of the different groups indicates the same succession of changes.

The character and conditions of the sedimentation would naturally produce strata in which fossils are very abundant. As in the Trenton period preceding, the bryozoa are the most abundant form of life. The quiet interior sea in which these strata were deposited proved a most congenial home for this form of life. Some strata are literally made up of their remains. Next in abundance are the brachiopods. The fragments of the broken shells of the latter sometimes compose beds of considerable thickness. Less than four per cent of all the forms known from the Cincinnati period, and these forms are of course widely distributed and generally subject to considerable variation, are found to range throughout. The great bulk of forms have usually a limited vertical range.

The following is a list of the forms which, as far as present knowledge goes, are found in all the groups of the Cincinnati period:

COELENTERATA.

Labechia? papillata (James). (c)

ECHINODERMATA.

Iocrinus subcrassus Meek and Worthen, and varieties.

BRYOZOA.

Ceramoporella ohioensis (Nicholson). (c)

Stomatopora arachnoidea (Hall). (c)

Stomatopora delicatula (James).

BRACHIOPODA.

Crania scabiosa Hall. (c)
Rafinesquina alternata Conrad-Emmons. (c)
Trematis millepunctata Hall.
Zygospira modesta Say-Hall. (c)

PELECYPODA.

Byssonychia radiata (Hall). (c)
Ctenodonta obliqua Hall.

GASTROPODA.

Cyclora depressa Ulrich.
" hoffmanni Miller.
" minuta Hall. (c)
" parvula Hall.
Lophospira tropidophora (Meek).
Microceras inornatum Hall. (c)
Protowarthia cancellata (Hall). (c)

CEPHALOPODA.

Cameroceras sp. (proteiforme Hall?).

VERMES.

Nereidavus varians Grinnell.

CRUSTACEA.

Aparchites minutissimus (Hall).
Asaphus gigas DeKay.
" maximus Locke.
Bollia persulcata Ulrich (c)
Bythocypris cylindrica (Hall).
Calymmene callicephala Green. (c)
Ulrichia nodosa Ulrich. (c)

POSITION UNCERTAIN.

Arthraria biclavata Miller.
Bythotrephis gracilis Hall.
" gracilis-crassa Hall.
Pasceolus globosus Billings.
Rusophycus bilobatum Vanuxem.

The Utica Group.

The Utica group in its typical exposures in the State of New York is described as consisting of black bituminous slates with a thickness at Utica, New York, of over 600 feet.* The Utica in northern Ohio, as revealed by drillings from the wells at Findlay and other places, is a black shale. Prof. Orton,† comparing the records of drillings, finds that the Utica or black shale thins out towards the south as the Ohio River is approached, but the overlying Hudson River shales, as he calls them, are increased in thickness. The thickness

* Walcott, C. D. The Utica Slate and Related Formations. Trans. Albany Institute, X, 1879, p. 1.
† Geol. Ohio, VI, p. 8.

of the two together is fairly constant. The color is not a matter of much importance. That the shales in southwestern Ohio are bluish or greenish in color, instead of black, does not preclude them from being of Utica age.

The series of shales at Cincinnati overlying the limestone strata now referred to the Point Pleasant beds, was denominated the middle or Eden shales by Prof. Orton.* As there can be no doubt of their Utica age, Prof. Orton's name lapses. Besides holding the same horizon in the geological scale as the New York Utica, the specific identity of several fossils, notably *Triarthrus becki*, very characteristic of the eastern Utica, has been established. Much more could not be asked. Besides being several hundred miles apart, the New York Utica was laid down under very different conditions and comparatively close to the source of its sediments, while the Ohio Utica was formed probably far from land in a large, rather shallow, interior sea. Under the circumstances the latter would have a very much more extensive and different fauna, especially if a barrier of some sort separated the two areas.

The Utica at Cincinnati consists mainly of soft bluish or grayish shales, of which some harden on exposure and others decompose. Some layers form a close approach to marl. To only a very limited extent is it a surface formation, but is often exposed by ravines around the city and by cuttings in the lower slopes of the hills. At no point can a continuous section be studied, nor is it easy to correlate different exposures, as they present great similarity in lithological features and few or none of the common Utica fossils have a short vertical range.

While the group consists mainly of shale, limestones are not altogether wanting, and occasionally a layer of limestone from four to six inches thick, or even more, will be found. The limestone forms, perhaps, one-tenth or one-eighth of the entire mass. Several of the limestones in the lower part are of the waved variety. Some of the shale layers abound in clay concretions. The thickness of the group at Cincinnati is about 260 feet.

* Geol., Ohio, I. 1873, p. 372.

The following list contains the species which range through the Utica.

COELENTERATA.

Climacograptus typicalis Hall.
Dendrograptus gracillimus Lesquereux.
Diplograptus putillus Hall.
Labechia? papillata James. (c)

ECHINODERMATA.

Ectenocrinus grandis (Meek).
" simplex Hall.
Heterocrinus heterodactylus Hall, varieties.
Heterocrinus heterodactylus-propinquus Meek.
Iocrinus subcrassus Meek and Worthen.
Lichenocrinus crateriformis Hall.

BRYOZOA.

Arthrostylus tenuis (James).
Batostoma implicatum (Nicholson). (c)
Bythopora arctipora (Nicholson). (c)
Callopora onealli-communis (James). (c)
Callopora onealli-sigillarioides (Nicholson). (c)
Ceramoporella distincta Ulrich. (c)
Ceramoporella ohioensis (Nicholson). (c)
Cœloclema concentricum (James). (c)
Peronopora vera Ulrich. (c)
Proboscina confusa (Nicholson).
Leptotrypa? clavis Ulrich.
Stomatopora arachnoidea (Hall). (c)
Stomatopora delicatula (James).

BRACHIOPODA.

Crania scabiosa Hall. (c)
Dalmanella multisecta (James-Meek). (c)
Lingula modesta Ulrich.
Plectambonites sericeus (Sowerby). (c)
Rafinesquina alternata Conrad-Emmons. (c)
Trematis millepunctata Hall.
Zygospira modesta Say-Hall.

PELECYPODA.

Byssonychia radiata (Hall). (c)
Clidophorus fabulus Hall.
" planulatus Conrad.
Ctenodonta obliqua (Hall).
" perminuta Ulrich.
Modiolopsis faba Emmons.

GASTROPODA.

Cyclora depressa Ulrich.
" hoffmanni Miller.
" minuta Hall. (c)
" parvula Hall.
Lophospira tropidophora (Meek).
Microceras inornatum Hall. (c)
Protowarthia cancellata (Hall). (c)

CEPHALOPODA.

Cameroceras sp. (proteiforme Hall?).
Orthoceras transversum Miller.

VERMES.

Nereidavus varians Grinnell.

Serpulites dissolutus Billings.

CRUSTACEA.

Acidaspis cincinnatiensis Meek, and varieties.

Acidaspis crossota (Locke).

Aparchites minutissimus (Hall).

Asaphus gigas DeKay.

" maximus Locke.

Bollia persulcata Ulrich (c)

Bythocypris cylindrica (Hall).

Calymmene callicephala Green. (c)

Ceratopsis chambersi (Miller). (c)

Lepidocoleus jamesi (Hall and Whitfield).

Primitia centralis Ulrich.

Ulrichia nodosa (Ulrich). (c)

POSITION UNCERTAIN.

Arthraria biclavata Miller.

Bythotrephis gracilis Hall.

" gracilis-crassa Hall.

Pasceolus globosus Billings.

Rusophycus bilobatum Vanuxem.

Lower Utica or Aspidopora newberryi Beds.

For convenience of study the group may be divided into three subdivisions, more easily distinguished faunally than lithologically, though close study shows lithological differences, which soon come to be felt, but are not easily described.

The lowest division to which the term Lower Utica will be applied, embraces about 80 feet and is on the whole rather unfossiliferous, that is, there are many layers in which fossils are scarce or wanting, but on the other hand there are some layers which are very prolific in fossils; on the whole, the fauna is an abundant one. In the number of species it excels the next two divisions, possibly because there have been more exposures and it has been more carefully hunted than the succeeding divisions. In this division, as in fact throughout the Cincinnati period, the trepostomatous bryozoa are the most abundant fossils in point of number of individuals; perhaps two-thirds of all the fossils are trepostomatous bryozoa. For a faunal designation the term *Aspidopora newberryi* beds is proposed, as this bryozoan is quite a characteristic and fairly abundant species in this division, but very rare, if occurring at all in the succeeding division of the Utica.

Exposures of these beds are constantly becoming rarer. Formerly they were frequently exposed by the various small streams which found their way into the Ohio, but nearly all of these have been transformed into sewers, and their valleys taken for streets and building sites. The lowest shales, occurring in the river bank in the First Ward (Fulton and Columbia), and accessible only in low water of the Ohio River, have yielded a fauna limited to a few feet vertically. Among the forms obtained in these strata are *Palæaster finei*, *Heterocrinus geniculatus*, *Merocrinus curtus*, *Plectambonites plicatellus*, *Ulrichia byrnesi*, *Elpe radiata*, *Triarthrus becki*, *Dicranograptus ramosus*, *Diplograptus whitfieldi*, *Dendrograptus tenuiramosus*, *Aspidopora areolata* and *Aspidopora newberryi*.

The limestones in this division are usually harder and not so bluish as in the remaining Utica strata. The lowest shales are greenish-gray, drab, or yellowish, but soon give way to shales of various shades of blue and gray.

The following list gives the fossils mainly restricted to this division, so far as known. A complete list will include those in the list on pages 68 and 69.

SPONGLÆ.

Lepidolites dickhauti Ulrich.

CŒLENTERATA.

Dendrograptus tenuiramosus Walcott.
Dicranograptus ramosus Hall.
Diplograptus whitfieldi Hall.

ECHINODERMATA.

Glyptocrinus pattersoni Miller.
Heterocrinus exilis Hall.
" geniculatus Ulrich.
Merocrinus curtus Ulrich.
Palæaster finei Ulrich.
Tæniaster fimbriatus (Ulrich).
" flexuosus (Miller and Dyer).

BRYOZOA.

Amplexopora petasiformis (Nicholson).
Amplexopora petasiformis-welchi (James).
Arthropora sp.
Aspidopora areolata Ulrich.
" newberryi (Nicholson).
" sp.
Atactopora hirsuta Ulrich.
Atactoporella newportensis Ulrich.
" typicalis Ulrich.
Callopora onealli (James).
Ceramoporella granulosa Ulrich, variety.
Crepipora solida (Ulrich).
" venusta (Ulrich).

Escharopora acuminata (James).
Hemiphragma whitfieldi (James). (c)
Leptotrypa? cortex Ulrich.
Monotrypa turbinata (James).
Monotrypella æqualis Ulrich.
Rhinidictya parallela (James).
Spatiopora sp.
Stictoporella flexuosa (James).

BRACHIOPODA.

Crania albersi Miller.
" dyeri Miller.
Dalmanella emacerata (Hall).
Leptæna rhomboidalis-gibbosa (James).
Leptobolus insignis Hall.
Lingula bisulcata Ulrich.
Orbiculoidea tenuistriata (Ulrich).
Pholidops cincinnatiensis Hall.
Plectambonites plicatellus (Ulrich).
Rafinesquina ulrichi (James).
Strophomena halliana Miller.
Trematis magna Ulrich.

PELECYPODA.

Byssonychia vera Ulrich.
Ctenodonta filistriata Ulrich.
Cymatonota productifrons Ulrich.
Lyrodesma cincinnatiense Hall.
" poststriatum Emmons.
Modiolopsis subtruncata Ulrich.
Nuculites? yoldiiformis Ulrich.
Orthodontiscus ovatus (Ulrich).
Psiloconcha tenuistriata Ulrich.
Pterinea mucronata Ulrich.
Rhytimya radiata Ulrich.
Technophorus cincinnatiensis Miller and Faber.

GASTROPODA.

Archinacella patelliformis (Hall).
Cyrtolites retrorsus Ulrich.
Fusispira terebriformis Hall.
Liospira micula (Hall).
Lophospira lirata Ulrich.
Tetranota obsoleta Ulrich and Scofield.

CEPHALOPODA.

Orthoceras junceum Hall.

VERMES.

Eotrophonia setigera Ulrich.
Protoscolex covingtonensis Ulrich
" ornatus Ulrich.
Protoscolex simplex Ulrich.
" tenuis Ulrich.

CRUSTACEA.

Elpe radiata (Ulrich).
Jonesella crepidiformis (Ulrich). (c)
Jonesella pedigera Ulrich.
Placentula inornata Ulrich.
Primitia centralis Ulrich.
" rudis Ulrich.
Primitiella claypoli Jones.
Primitiella unicornis Ulrich.
" whitfieldi Jones.
Triarthrus becki Green.
Trinucleus bellulus Ulrich.
" concentricus Eaton.
Ulrichia bivertex Ulrich.
" byrnesi (Miller).

POSITION UNCERTAIN.

Asaphoidichnus dyeri Miller.
" trifidum Miller.
Bythotrephis ramulosa Miller.
Dactylophycus quadripartitum Miller and Dyer.
Dactylophycus tridigitatum Miller and Dyer.
Ormathichnus moniliforme Miller.
Petalichnus multipartitum Miller.
Rusophycus asperum Miller and Dyer.
Sphenophyllum primævum Lesquereux.
Teratichnus confertum Miller.
Trachomatichnus cincinnatiense Miller.
Trachomatichnus numerosum Miller.
Trachomatichnus permultum Miller.
Trichophycus sulcatum Miller and Dyer.

Middle Utica or Batostoma jamesi Beds.

No sharp dividing lines can be drawn separating this series of beds from either the lower or upper Utica. The thickness is about 120 feet. This division has a somewhat less proportion of limestone than the other divisions of the Utica and is much less rich faunally. Exposures are not uncommon, but are rarely of a character to yield many fossils; that is, they usually show the edges of the outcropping strata, but are seldom thrown out and given a chance to weather. From the abundance of the bryozoan *Batostema jamesi* (Nicholson) the beds may be known as the *Batostoma jamesi* beds.

In addition to the fossils given in the list of those ranging through the Utica, the following occur, most of which are restricted to this division:

CŒLENTERATA.

Dictyonema arbusculum (Ulrich).

ECHINODERMATA.

Lichenocrinus dubius Miller.

BRYOZOA.

Amplexopora petasiformis (Nicholson), variety.
Aspidopora eccentrica (James).
Batostoma implicatum (Nicholson). (c).
Batostoma jamesi (Nicholson). (c).
Bythopora arctipora (Nicholson).
Callopora onealli - communis (James). (c).
Callopora onealli - sigillarioides (Nicholson). (c).
Callopora sp.
Ceramoporella distincta Ulrich.
" granulosa Ulrich, variety.

Ceramoporella ohioensis (Nicholson).
Cœloclema alternatum (James).
Dekayella ulrichi (Nicholson).
Hemiphragma whitfieldi (James), variety.
Peronopora vera Ulrich. (c).
Proboscina confusa (Nicholson).

BRACHIOPODA.

Dalmanella emacerata (Hall).
Pholidops cincinnatiensis Hall.
Rafinesquina squamula (James).
Strophomena halliana Miller.

PELECYPODA.

Clidophorus ellipticus Ulrich.
Lyrodesma conradi Ulrich.
Modiolopsis angustata Ulrich.
" parva Ulrich.
" simulatrix Ulrich.
Orthodesma occidentale Miller.
Orthodontiscus mediocardinalis (Miller).
Orthodontiscus ovatus (Ulrich).
Psiloconcha minima Ulrich.

GASTROPODA.

Archinacella patelliformis (Hall).
Cyrtolites carinatus Miller.
Hormotoma gracilis - angustata Hall.
Liospira micula (Hall).
Lophospira lirata Ulrich.
Protowarthia granistriata Ulrich.
" planidorsata Ulrich.
Trochonema nitidum Ulrich.

CEPHALOPODA.

Cyrtoceras magister Miller.
" ortoni (Meek).
" ventricosum Miller.
Trocholites minusculus Miller and Dyer.

CRUSTACEA.

Proetus spurlocki Meek.
Ctenobolbina ciliata (Emmons). (c).

Upper Utica or Dekayella ulrichi Beds.

This division of the Utica is exceedingly fossiliferous, but the fauna is mainly of a bryozoan character. Limestones, especially of a thin, slabby kind, are considerably more numerous than in the divisions below, two heavy layers being usually found at its bottom. Although *Dekayella ulrichi* (Nicholson) occurs plentifully in the middle Utica, it is so very abundant in these beds that the name *Dekayella ulrichi* beds seems an appropriate faunal designation. The thickness of this division is about sixty feet. The beds have been frequently exposed in grading for streets and other purposes, so that the fauna is fairly well known.

In addition to the fossils in the list on pages 68 and 69, the following are found in the upper Utica:

BRYOZOA.

Amplexopora septosa (Ulrich).
Arthropora shafferi-cleavelandi (James).
Atactopora hirsuta Ulrich.
Batostoma jamesi (Nicholson). (c)
Berenicea vesiculosa Ulrich.
Bythopora parvula James.
Callopora nodulosa (Nicholson).
Ceramoporella granulosa Ulrich, variety.
Ceramoporella granulosa - milfordensis (James).
Cœloclema alternatum (James). (c)
Constellaria constellata - prominens Ulrich.
Crepipora simulans Ulrich.
Dekayella obscura Ulrich.
" ulrichi (Nicholson). (c)
" ulrichi-robusta Foord.
Dekayia maculata (James).
Escharopora falciformis (Nicholson), variety.
Phylloporina variolata (Ulrich).
Stomatopora arachnoidea - tenuissima Ulrich.

GASTROPODA.

Bellerophon capax Ulrich.

CRUSTACEA.

Ctenobolbina alata Ulrich.
" bispinosa Ulrich.
Ctenobolbina ciliata-curta Ulrich.

POSITION UNCERTAIN.

Rusophycus pudicum Hall.
Protostigma sigillaroides Lesquereux.

The Lorraine Group.

The Lorraine at Cincinnati as compared with the underlying Utica contains much less shale and more limestone. The shales are bluish or yellowish, and often marly. The limestones are even-bedded, on an average four or five inches thick, and bluish in color. No markedly waved layers have been observed in the Lorraine. All the higher strata at Cincinnati belong to the Lorraine, and for twenty or thirty miles around the city the streams expose these strata. The Lorraine is also found in Kentucky and Tennessee. Mt. Parnassus at Columbia, Tennessee, is a noted locality for Lorraine fossils.

The Lorraine in Ohio is easily separable on faunal grounds, with corresponding more or less well-marked lithological characters, into six series of beds or subdivisions. In descending order these are:

6. Warren or *Homotrypa bassleri* Beds,	about 80 feet.
5. Mt. Auburn or *Platystrophia lynx* Beds	about 20 feet.
4. Corryville or *Chiloporella nicholsoni* Beds,	about 60 feet.
3. Bellevue or *Monticulipora molesta* Beds,	about 20 feet.
2. Fairmount or *Dekayia aspera* Beds,	about 80 feet.
1. Mt. Hope or *Amplexopora septosa* Beds,	about 50 feet.

The Lorraine is exceedingly fossiliferous. Throughout the trepostomatous bryozoa are very abundant. Some forms it has in common with the underlying Utica and the overlying Richmond, yet the number is surprisingly small in comparison with the entire fauna. Owing to their usually having a restricted range, the bryozoa are excellent horizon markers.

The species which range through the Lorraine, though in some beds, as, e. g., the Bellevue Beds, they may occur very rarely, are as follows:

CŒLENTERATA.

Labechia? papillata (James). (c)

ECHINODERMATA.

Heterocrinus heterodactylus Hall, varieties.
Iocrinus subcrassus Meek and Worthen, varieties.
Lepidodiscus cincinnatiensis (Rœmer).

BRYOZOA.

Ceramoporella ohioensis (Nicholson). (c)
Stomatopora arachnoidea (Hall). (c)
Stomatopora delicatula (James).

BRACHIOPODA.

Crania lælia Hall.
" scabiosa Hall (c)
Hebertella sinuata (Hall). (c)
Platystrophia laticostata (James-Meek), and varieties. (c)
Rafinesquina alternata Conrad-Emmons. (c)
Trematis millepunctata Hall.
Zygospira modesta Say-Hall. (c)

PELECYPODA.

Byssonychia radiata (Hall). (c)
Clidophorus fabulus (Hall).
Ctenodonta obliqua (Hall).
Ctenodonta perminuta Ulrich.
Pterinea demissa Conrad (c)

GASTROPODA.

Coleolus iowensis James.
Conularia formosa Miller and Dyer.
Cyclora depressa Ulrich.
" hoffmanni Miller.
" minuta Hall. (c)
" parvula Hall.
Cyrtolites ornatus Conrad. (c)
Hyolithes parvinsculus Hall
Lophospira bowdeni (Safford).(c)
" tropidophora (Meek).
Microceras inornatum Hall. (c)
Protowarthia cancellata (Hall).(c)
Shizolopha moorei Ulrich.

CEPHALOPODA.

Cameroceras sp. (proteiforme Hall?).

VERMES.

Cornulites corrugatus(Nicholson).
" sterlingensis (Meek and Worthen).
Nereidavus varians Grinnell.
Serpulites dissolutus Billings.

CRUSTACEA.

Acidaspis cincinnatiensis Meek, and varieties.
Aparchites minutissimus (Hall).
Bollia persulcata Ulrich. (c)
Bythocypris cylindrica (Hall).
Calymmene callicephala Green.(c)
Isotelus gigas DeKay.
" maximus Locke.
Lepidocoleus jamesi (Hall and Whitfield.
Ulrichia nodosa (Ulrich). (c)

POSITION UNCERTAIN.

Arthraria biclavata Miller.
Bythotrephis gracilis Hall.
" gracilis-crassa Hall.
Pasceolus globosus Billings.
Rusophycus bilobatum Vanuxem.
" pudicum Hall.

Mt. Hope or Amplexopora septosa Beds.

Overlying the Utica are several heavy, rather irregularly bedded limestones roughish in character. The layer of limestone which usually caps the Utica shale varies from eight to sixteen inches in thickness. It is a mass of fossils, mainly *Dalmanella multisecta;* the reddish specimens of this little shell sprinkling its upper surface render it an easily recognized stratum. This and several succeeding limestone layers are sometimes quarried but do not afford a very satisfactory

building stone; they do not dress well, and are usually so situated as not to be worked with profit. In Newport, Kentucky, they are about 300 feet above the Cincinnati city datum, low-water mark of the Ohio river, which is 432 feet above tide.

The horizon of the *Strophomena planoconvexa*, which has a very limited vertical range, is regarded as marking the boundary between the Mt. Hope beds and the succeeding Fairmount beds. Limestones are more abundant than in the upper Utica, but not so abundant as in the Fairmount beds, and these, and the intervening shales as well, are often inclined to be sandy. Occasionally there are layers showing the fossils as casts upon weathering. The few feet of limestones and intervening shales capping the upper Utica beds are crowded with bryozoa of about the same kinds as the beds just below them, but fossils soon become scarcer, and as a whole these beds appear to have a rather meager fauna. This may be only apparent, however, due to their rarely being exposed. The name Mt. Hope beds has been given from an exposure found on the southeastern slope of Price Hill, known as Mt. Hope, where the strata are more clayey and less sandy than usual and the fossils better preserved. Although the *Amplexopora septosa* occurs rather sparingly in the upper Utica, it is very characteristic and abundant and finely developed in these beds, and so has been selected for the faunal designation.

In addition to the species ranging through the Lorraine, the following are found in these beds:

SPONGIÆ.

Anomalospongia reticulata Ulrich.

BRYOZOA.

Amplexopora septosa (Ulrich).(c)
Batostoma sp.
Callopora dalei (Edwards and Haime). (c)
Callopora nodulosa (Nicholson).
" subplana Ulrich.
Constellaria constellata-plana Ulrich.
Constellaria constellata-prominens Ulrich.
Dicranopora emacerata (Nicholson).
Heterotrypa sp.
Monticulipora mammulata D'Orbigny.
Peronopora vera Ulrich. (c)

BRACHIOPODA.

Dalmanella multisecta (James-Meek).

PELECYPODA.

Ctenodonta pectunculoides (Hall) Modiolopsis milleri Ulrich.

GASTROPODA.

Cyclonema gracile Ulrich.

VERMES.

Arabellites lunatus Hinde.
" quadratus Hinde.
Eunicites simplex Hinde.
Lumbriconereites dactylodus Hinde.
Scolithus tuberosus Miller and Dyer.

POSITION UNCERTAIN.

Discophycus typicale Walcott.

Fairmount or Dekayia aspera Beds.

This division of the Lorraine was early known as the Stone Quarries and later by Orton's name, Hill Quarry beds. The name Fairmount is proposed because all the hills in that part of the city known as Fairmount, lying north from Price Hill and south or southwest from Cumminsville and immediately west of Mill Creek, in which numerous quarries have been opened, show these strata and none higher. The highest strata in the hills surrounding Newport and Covington also belong to this division. These beds, whose thickness is about eighty feet, are characterized by regular aternations of evenly-bedded, bluish limestones from two to six inches thick, rarely more, and bluish or sometimes pale yellowish or brownish shales. The limestones form at least a third of the whole mass and are easily quarried out. The stone is mostly used for foundation work for residences, though it has also been very tastefully employed to form the walls of a number of church edifices and other buildings of a quasi-public character. The stone when burned forms a rather strong lime, which has a limited use locally. At one time the making of lime was quite an industry, but the purer grades of lime shipped in have almost displaced the home-made article.

With this division the Lorraine fauna is fairly inaugurated. The fauna is quite different from that in the Utica beds. Fossils cannot be said to be really abundant, that is, as compared with the upper Utica or the succeeding divisions of the Lorraine, but in variety the Fairmount beds excel all other divisions of the Cincinnati period, with the possible exception of the lower Richmond. The fossils are usually well, and often beautifully preserved, and can ordinarily be had free through the weathering of the shales between the limestones. The limestone layers usually show the fossils of which they are composed, and their upper and lower surfaces are often a mass of fossils, projecting more or less from the matrix.

In addition to the forms which range through the Lorraine the following occur in the Fairmount beds:

SPONGIÆ.

Cylindrocœlia covingtonensis Ulrich.
Dystactospongia insolens Miller.
Hindia sphæroidalis-gregaria Miller and Dyer.

ECHINODERMATA.

Anomalocrinus incurvus (Meek and Worthen).
Cyclocystoides bellulus Miller and Dyer.
Cystaster granulatus (Hall).
Dendrocrinus cincinnatiensis (Meek).
Ectenocrinus grandis (Meek).
Glyptocrinus decadactylus Hall.
Hemicystites stellatus (Hall).
Ohiocrinus laxus (Hall).
" oehanus (Ulrich).
Palæaster clarkanus Miller.
" dyeri Meek.
" granulosus Hall.
" jamesi (Dana).
" shafferi Hall.
Ptychocrinus parvus (Hall).
Streptaster vorticellatus (Hall).
Tæniaster granuliferus (Meek).

BRYOZOA.

Amplexopora cingulata Ulrich.
" ? discoidea (Nicholson).
Amplexopora septosa (Ulrich).
" sp.
Arthropora shafferi (Nicholson), variety.
Arthropora sp.
Atactopora hirsuta Ulrich.
" maculata Ulrich.
Atactoporella multigranosa (Ulrich).
Atactoporella mundula (Ulrich).
" tenella (Ulrich).
Bythopora dendrina (James).
" gracilis (Nicholson). (c)
Callopora dalei (Edwards and Haime). (c)
Callopora subplana Ulrich.

Callopora sp.
Ceramoporella distincta Ulrich.
" granulosa Ulrich, variety.
Ceramoporella ohioensis (Nicholson). (c)
Constellaria constellata Dana. (c)
" constellata-plana Ulrich.
Crepipora impressa Ulrich.
" simulans Ulrich.
Dekayia aspera Edwards and Haime. (c)
Dekayia multispinosa Ulrich.
Dicranopora emacerata (Nicholson).
Dicranopora internodia (Miller and Dyer).
Discotrypa elegans (Ulrich).
Escharopora falciformis (Nicholson).
Escharopora maculata Ulrich.
" pavonia (D'Orbigny). (c)
Heterotrypa frondosa(D'Orbigny). (c)
Heterotrypa solitaria Ulrich.
" subpulchella (Nicholson).
Heterotrypa sp.
Homotrypa curvata Ulrich.
" flabellaris Ulrich.
" obliqua Ulrich. (c)
" sp.
Homotrypella sp.
·Leptotrypa? irregularis (Ulrich).
" ? semipilaris Ulrich.
Monticulipora mammulata D'Orbigny.
Peronopora vera Ulrich.
Petigopora gregaria Ulrich.
" petechialis (Nicholson).
Phylloporina clathrata (Miller and Dyer).
Spatiopora aspera Ulrich.
" corticans (Nicholson).
" lineata Ulrich.
" maculosa Ulrich.
" tuberculata (Edwards and Haime).
Stomatopora inflata (Hall).

BRACHIOPODA.

Dalmanella bellula (James-Meek).
" meeki (Miller).
Lingula cincinnatiensis (Hall and Whitfield).
Lingula modesta Ulrich.
Orthorhynchula linneyi (James-Nettleroth).
Pholidops cincinnatiensis Hall.
Platystrophia crassa (James-Meek).
Plectorthis dichotoma (Hall).
" ? ella (Hall).
" æquivalvis (Hall).
" fissicosta (Hall).
" plicatella (Hall). (c).
" ? sectostriata (Ulrich)
" triplicatella (Meek).
Rafinesquina alternata-fracta (Meek).
Rafinesquina alternata-loxorhytis (Meek).
Rafinesquina squamula (James).
Schizambon? lockii Winchell and Schuchert.
Schizocrania filosa Hall and Whitfield.
Strophomena planoconvexa Hall.
" sinuata James-Meek.
Trematis crassipunctata Ulrich.
" dyeri Miller.
" oblata Ulrich.
Zygospira cincinnatiensis James-Meek.
Zygospira concentrica Ulrich.

PELECYPODA.

Allonychia ovata Ulrich.
Anomalodonta plicata Ulrich.
Byssonychia acutirostris Ulrich.
" imbricata Ulrich.
" retrorsa (Miller).
Ctenodonta pectunculoides (Hall).
Cuneamya cordiformis Miller.
" parva Miller.
Cymatonota pholadis (Conrad).
" recta Ulrich.
Eridonychia apicalis Ulrich.
" paucicostata Ulrich.
Eurymya alata (Ulrich).
Ischyrodonta unionoides (Meek).
Lyrodesma grande Ulrich.
" inornatum Ulrich.
Modiolodon obtusus Ulrich.
" truncatus (Hall).
Modiolopsis faba Emmons.
" faberi Miller.
" longa Miller and Faber.
" milleri Ulrich.
" modiolaris (Conrad).
" parallela Ulrich.
Opisthoptera ampla Ulrich.
Opisthoptera notabilis Ulrich.
Orthodesma faberi Miller.
" nasutum Conrad.
Orthonotella faberi Miller.
Physetomya acuminata Ulrich.
Psiloconcha inornata Ulrich.
" sinuata Ulrich.
" subovalis (Ulrich).
Pterinea cincinnatiensis Miller and Faber.
Pterinea rugatula Miller and Faber.
Pyanomya faberi Miller.
" gibbosa Miller.
Rhytimya ashmani Miller and Faber.
Rhytimya compressa Ulrich.
" oehana Ulrich.
" producta Ulrich.
" scaphula Miller and Faber.
Sedgwickia? compressa Meek.
" ? fragilis Meek.
Technophorus faberi Miller.
" punctostriatus Ulrich.

GASTROPODA.

Bellerophon capax Ulrich.
Bucanopsis carinifera Ulrich.
Clathrospira conica Ulrich and Scofield.
Conradella bellula Ulrich.
Cyclonema inflatum Ulrich.
" limatum Ulrich.
Cyclonema mediale Ulrich.
" pyramidatum James.
" sublæve Ulrich.
" transversum Ulrich.
Lophospira ampla Ulrich.
Microceras minutissimum Ulrich.
Seelya mundula Ulrich.

CEPHALOPODA.

Cyrtoceras conoidale Wetherby.
" vallandighami Miller.
Orthoceras byrnesi Miller.
" cincinnatiense Miller.
Orthoceras meeki Miller.
" turbidum Hall and Whitfield.

VERMES.

Arabellites aciculatus James.
" hindei James.
Cornulites flexuosus (Hall).
Cornulites minor Nicholson.
Walcottia rugosa Miller and Dyer.

CRUSTACEA.

Acidaspis anchoralis Miller.
Ctenobolbina? tumida Ulrich.
Dalmanites callicephalus Hall.
Dalmanites carleyi Meek.
Elpe cincinnatiensis (Meek).

POSITION UNCERTAIN.

Heliophycus stelliforme Miller and Dyer.
Trichophycus venosum Miller.

Bellevue or Monticulipora molesta Beds.

Overlying the quarry layers is a small series of beds, of rather shelly limestone, thinner than those below and harder, which the eye readily distinguishes as quite different from the layers below. In the bluff at the bend in Clifton Avenue, just under the old Bellevue House, a one-time landmark which has recently disappeared, these layers project out boldly near the top of the bluff, above the strata of the Fairmount beds. The beds are almost a mass of bryozoa, and hence contain few other fossils. The *Monticulipora molesta* which, if not restricted to these beds, at least here attains its maximum development in size and numbers, is one of the most characteristic of these bryozoa and has been chosen for the faunal designation. The thickness of these beds is abcut fifteen feet.

Immediately above are about five feet considerably different lithologically and somewhat faunally, which we include in this division. These upper layers are largely composed of single valves and broken fragments of *Rafinesquina alternata*, variety, though entire specimens are not uncommon. The *M. molesta* occurs also in these layers, but has not been found in the next division.

In addition to the forms ranging through the Lorraine, the following occur:

BRYOZOA.

Amplexopora filiosa (D'Orbigny).
" robusta Ulrich.
Atactoporella multigranosa (Ulrich).
Atactoporella mundula (Ulrich).
" ortoni (Nicholson).
" tenella (Ulrich).
Atactoporella sp.
Bythopora gracilis (Nicholson). (c).
Callopora ramosa (D'Orbigny). (c)
Ceramoporella granulosa Ulrich, variety.

Ceramoporella whitei (James).
" sp.
Dekayia sp.
Heterotrypa sp.
Homotrypa obliqua Ulrich. (c)
Monticulipora molesta Nicholson. (c)
Nicholsonella vaupeli Ulrich.
Peronopora compressa (Ulrich).
Peronopora decipiens (Rominger).
Petigopora asperula Ulrich.
" gregaria Ulrich.
" petechialis Nicholson.
Proboscina auloporoides (Nicholson).
Proboscina frondosa (Nicholson).
Stomatopora inflata (Hall).

BRACHIOPODA.

Platystrophia lynx (Eichwald), variety.
Schizocrania filosa Hall and Whitfield.

Corryville or Chiloporella nicholsoni Beds.

In this division the limestones are thinner and less frequent than in the quarry beds and the shales more yellowish. Blue shale also occurs. Price Hill and the higher hills of the "Cincinnati island" (see *ante*, p. 50) expose these beds. Formerly Corryville abounded in exposures, but has been so covered with residences that the underlying strata are now seldom seen. One of the most characteristic bryozoa, very abundant in these beds, if not restricted to them, is the *Chiloporella nicholsoni*. At the present time Fairview Heights affords a number of exposures of these layers. Owing to these strata having been largely cut into in the course of the transformation of the hill tops into the residence portion of the city, their fauna has become well known.

In addition to the species ranging through the Lorraine, the following occur:

SPONGIÆ.

Leptopoterion mammiferum Ulrich.
Pattersonia difficilis Miller.
" ulrichi Rauff.

ECHINODERMATA.

Anomalocrinus caponiformis (Lyon).
Anomalocystites balanoides Meek.
Cyclocystoides cincinnatiensis Miller and Faber.
Cyclocystoides nitidus Faber.
Dendrocrinus posticus (Hall).
Glyptocrinus dyeri Meek.
" dyeri-sublævis Miller.
" subglobosus Meek.
Heterocrinus pentagonus Ulrich.
Lepidodiscus holbrooki (James).
" pileus (Hall).
" warrenensis (James).

Lichenocrinus dyeri Hall.
Ohiocrinus compactus (Meek).
" constrictus (Hall).
Palæaster incomptus Meek.
Palæaster spinulosus Miller and Dyer.
Streptaster? vorticellatus (Hall).

BRYOZOA.

Amplexopora filiosa (D'Orbigny).
Arthropora shafferi (Meek).
Atactopora sp.
Berenicea primitiva Ulrich.
" sp.
Bythopora dendrina (James).
" gracilis (Nicholson).(c)
Callopora andrewsi (Nicholson).
" ramosa (D'Orbigny). (c)
" rugosa (Edwards and Haime). (c)
Callopora sp.
Ceramoporella granulosa Ulrich, variety.
Ceramoporella whitei (James).
" sp.
Chiloporella nicholsoni (James) (c)
Dekayia appressa Ulrich.
" pelliculata Ulrich.
Heterotrypa inflecta Ulrich.
Homotrypa obliqua Ulrich. (c)
Monticulipora cincinnatiensis (James).
Peronopora compressa (Ulrich.) (c)
" decipiens (Rominger).
Petigopora asperula Ulrich.
" gregaria Ulrich.
" petechialis Nicholson.
Proboscina auloporoides (Nicholson).
Proboscina frondosa (Nicholson).
Spatiopora tuberculata (Edwards and Haime).
Spatiopora sp.
Stomatopora inflata (Hall).

BRACHIOPODA.

Platystrophia sp.
Rafinesquina alternata - nasuta (Conrad). (c)
Schizocrania filosa Hall and Whitfield.
Trematis umbonata Ulrich.

PELECYPODA.

Allonychia jamesi (Meek).
" subrotunda Ulrich.
Byssonychia alveolata Ulrich.
" præcursor Ulrich.
Cardiomorpha obliquata Meek.
Cuneamya elliptica Miller.
Modiolodon truncatus (Hall).
Modiolopsis faba Emmons.
Orthodesma mundum Miller and Faber.
Orthodesma parvum Ulrich.
Psilonychia perangulata Ulrich.
Pyrenomœus decipiens Ulrich.
Rhytimya convexa Ulrich.
" mickelboroughi (Whitfield).

GASTROPODA.

Bellerophon recurvus Ulrich.
Conradella elegans (Miller).
Cyclonema humerosum Ulrich.
Cyclonema simulans Ulrich.
Dyeria costata (James).

CEPHALOPODA.

Gomphoceras cincinnatiense Miller.
Gomphoceras faberi Miller.
Orthoceras dyeri Miller.
" harperi Miller.

VERMES.

Walcottia cookana Miller and Dyer.

CRUSTACEA.

Ceratopsis oculifera (Hall).
Ceraurus milleranus Miller and Gurley.
Ctenobolbina duryi (Miller).
Elpe cincinnatiensis (Meek).
Elpe irregularis (Miller).
Lichas halli Foerste.
Placentula marginata Ulrich.
Primitia centralis Ulrich.
Proetus parviusculus Hall.

POSITION UNCERTAIN.

Blastophycus diadematum Miller and Dyer.
Bythotrephis ramulosa Miller.
Licrophycus flabellum Miller and Dyer.

Mt. Auburn or Platystrophia lynx Beds.

These beds were selected by Prof. Orton to mark the dividing line between the Cincinnati beds proper and the Lebanon division, but their thickness is much greater than was probably suspected. At Cincinnati but few localities have an altitude great enough to show them. The city water tanks on Price Hill rest on them; the higher parts of McMillan Street, on Clifton Heights, were cut through them. Over a considerable part of Mt. Auburn they formed the surface rock with numerous exposures before the growth of the city covered this beautiful hilltop with residences. The high ridge extending from west of Price Hill north through Westwood shows these beds wherever cut into. They are finely exposed in Reservoir Creek, north of Lebanon, Ohio. Their thickness is about twenty feet. The lower five to twelve feet contain an abundance of the large Orthid, *Platystrophia lynx*, known in common parlance as double-headed Dutchman; in the remainder this brachiopod is much less abundant, otherwise the fauna is much the same. The most characteristic bryozoa are the *Cœloclema oweni* and a fine species of *Homotrypa* as yet undescribed. The beds are mainly blue shale, though sometimes yellowish in exposure, with some rather

irregularly bedded limestone. The following fossils occur in addition to those listed on pages 75 and 76. The fauna is mainly bryozoan. These beds have not received much attention at the hands of collectors, which may explain the brevity of the following list:

BRYOZOA.

Amplexopora sp. (c)
Arthropora shafferi (Meek).
Atactoporella sp.
Berenicea sp.
Bythopora gracilis (Nicholson). (c)
Callopora sp.
Ceramoporella whitei (James).
Cœloclema oweni (James). (c)
Crepipora simulans Ulrich.
Dekayia sp.
Dicranopora emacerata (Nicholson).
Eridotrypa sp.
Heterotrypa sp.
Homotrypa sp. (c).
Peronopora compressa (Ulrich).
" decipiens (Rominger).
Petigopora petechialis (Rominger).
Proboscina frondosa (Nicholson).
Stomatopora inflata Hall.

BRACHIOPODA.

Platystrophia lynx (Eichwald). (c)

Warren or Homotrypa bassleri Beds.

The Mt. Auburn beds pass with little distinction into the next series of beds. For these the name Warren beds is proposed, because they are exposed in a number of streams in the vicinity of Lebanon, Oregonia, and other places in Warren County. The most characteristic bryozoan is perhaps the *Homotrypa bassleri.** These strata were included by Orton in the Lebanon beds, but their fauna shows them to be much more nearly related to the Lorraine beds beneath than to the Richmond above. Toward the top of this division the layers, both limestone and shale, especially the latter, become rough and nodular, indicating a marked change in the sedimentation. For this reason these layers are considered to mark the close of the Lorraine. Immediately after them come the even-bedded limestones and marly shales of the lower Richmond. Limestone is not very abundant in the beds under consideration, whose thickness is about eighty feet. The intercalated shales are of a dark bluish color, rather marly.

* For description of this species see this journal, Vol. XX., Article IV.

Fossils do not appear to be nearly as abundant as in beds underlying or overlying. But these beds have received little attention from collectors. Careful collecting may show a large and varied, as well as characteristic fauna.* About thirty-five feet below the top of these beds occurs the stratum of the noted *Dinorthis retrorsa* (Salter), of very limited extent vertically, but very persistent horizontally. This Orthid is abundant in this stratum, but seems to be restricted to it.

The following species are considered to occur in the Warren beds in addition to those given as ranging through the Lorraine:

BRYOZOA.

Amplexopora sp.
Batostoma varians (James). (c)
Berenicea sp.
Callopora sp.
Ceramoporella granulosa Ulrich, variety.
Ceramoporella whitei (James).
" sp.
Cœloclema sp.
Heterotrypa sp.
Homotrypa bassleri Nickles. (c)
Leptotrypa? dychei (James).
Lioclemella sp.
Mesotrypa sp.
Nicholsonella sp.
Peronopora compressa (Ulrich).
" decipiens (Rominger).
Proboscina frondosa (Nicholson).
Rhopalonaria venosa Ulrich.

BRACHIOPODA.

Dinorthis retrorsa (Salter).

PELECYPODA.

Anomalodonta alata Meek.
Ctenodonta madisonensis Ulrich.
Cymatonota constricta Ulrich.
Cymatonota cylindrica (Miller and Faber).
Modiolodon subovalis Ulrich.

*It is quite probable that a few of the forms, which in this paper are listed as belonging to the lower Richmond, will prove to belong to the Warren beds. The recognition of the fact that the Cincinnati period consists of the three well-marked groups, Utica, Lorraine, and Richmond, is comparatively recent. And still more recently has it been seen that in each are well-marked divisions, easily recognized when once the faunal and lithological differences are known. A very large number of the fossils described from the Cincinnati period are rare forms; some are unique, but a single specimen being known. So long as the idea prevailed that the Cincinnati group, as it was then called, was homogeneous and indivisible, collectors were indifferent as to the exact horizon of their finds. Hence, when those who described fossils, give simply Cincinnati, Ohio, as the locality, it is often a matter of conjecture from just which particular division the fossil came. For this reason the lists given in this paper must be considered largely provisional. I have to acknowledge gratefully the very great help I have received in placing the fossils in their various beds from my friends, Messrs. E. O. Ulrich and R. S. Bassler, whose full and accurate knowledge of the Cincinnati fossils and their horizons has been freely at my service.

GASTROPODA.

Cyclonema bilix-fluctuatum James.
Cyclora pulcella Miller.

CEPHALOPODA.

Orthoceras mohri Miller.

VERMES.

Polygnathus wilsoni James. Prioniodus dychei James.

CRUSTACEA.

Aparchites oblongus Ulrich.
Ctenobolbina ciliata - hammelli (Miller and Faber).
Primitia cincinnatiensis (Miller). (c)

POSITION UNCERTAIN.

Dystactophycus mamillanum Miller and Dyer.

The Richmond Group.

The Richmond embraces the uppermost beds of the Cincinnati period. In Ohio and Indiana they form an irregular belt, surrounding Cincinnati at a distance of from thirty to fifty miles. The localities in these States most noted for their fossils are Lebanon (not in the immediate vicinity, however), Freeport or Oregonia, Waynesville, Clarksville, Morrow, Westboro, Blanchester, Camden, and Oxford in Ohio; Richmond, Weisburg, Versailles, and Madison in Indiana.

The rocks are even-bedded limestones, usually dove-colored or grayish rather than bluish, from two to ten or more inches in thickness, with regular shale alternations, the limestone forming from one-fourth to one-half the whole mass.

The Richmond has received but little careful, detailed study, not enough to establish the boundaries or lithological characters of the divisions. The indications are that there are three well marked divisions, which for the present are designated as lower, middle, and upper Richmond. The lower Richmond seems to be strongly developed on the eastern side of the Cincinnati uplift, where the middle is feebly developed and the upper probably not at all. The middle division is finely shown at Richmond, Indiana, and at other points on the western side of the uplift. On this same

side the upper is feebly developed toward the north, but becomes stronger toward the south, and probably has its strongest development in Kentucky. The Cumberland sandstone of Kentucky probably belongs to this division. The Richmond beds of Tennessee,* and those formed in the western and northwestern parts of the ancient interior sea, now exposed at Wilmington and Sterling, Illinois, and Spring Valley, Minnesota, perhaps also those shown at Delafield and Iron Ridge, Wisconsin, all of which have been referred to the Cincinnati period, may represent a phase later than any of the Richmond of Ohio and Indiana.

The Richmond group has a very extensive and varied fauna, and, as a whole, very different from the underlying Lorraine. Corals are unknown in the Lorraine, the Richmond has a considerable number. The bryozoan fauna of both lower and middle Richmond is very extensive; many new species of bryozoa have been discovered which await description.

The following list contains the species which, so far as present knowledge goes, range through the Richmond.

COELENTERATA.

Labechia? papillata (James). (c)
Protarea vetusta (Hall), variety. (c)
Streptelasma rusticum Billings. (c)

ECHINODERMATA.

Iocrinus subcrassus Meek and Worthen, varieties.

BRYOZOA.

Berenicea sp.
Ceramoporella granulosa Ulrich, variety.
Ceramoporella ohioensis (Nicholson). (c)
Constellaria polystomella Nicholson.
Fenestella granulosa Whitfield.
Homotrypa flabellaris Ulrich. (c)
Homotrypella sp.
Monotrypella quadrata (Rominger). (c).
Monotrypella subquadrata Ulrich.
Peronopora decipiens (Rominger). (c)
Prasopora hospitalis (Nicholson).
Stomatopora arachnoidea (Hall). (c)
Stomatopora delicatula (James).
" inflata (Hall).

* For many of the facts in this paragraph I am indebted to Mr. E. O. Ulrich, whose field investigations, particularly in Tennessee, promise to throw a great deal of light upon the Richmond and other Ordivician formations.

BRACHIOPODA.

Crania lælia Hall.
" scabiosa Hall. (c)
Hebertella occidentalis Hall.
" sinuata Hall.
Platystrophia laticostata (James-Meek), varieties.
Rafinesquina alternata Conrad-Emmons. (c)
Rhynchotrema capax (Conrad). (c)
Trematis millepunctata Hall.
Zygospira modesta Say-Hall.

PELECYPODA.

Byssonychia radiata (Hall). (c)
Ctenodonta obliqua (Hall).
Ctenodonta recurva Ulrich.
Pterinea demissa Conrad. (c)

GASTROPODA.

Coleolus iowensis James.
Conularia formosa Miller and Dyer.
Cyclonema bilix (Conrad).
" bilix-fluctuatum James.
Cyclora depressa Ulrich.
" hoffmanni Miller.
" minuta Hall. (c)
Cyclora parvula (Hall).
Hyolithes parviusculus Hall.
Lophospira bowdeni Safford. (c)
" tropidophora (Meek).
Microceras inornatum Hall. (c)
Protowarthia cancellata (Hall). (c)
Schizolopha moorei Ulrich.

CEPHALOPODA.

Cameroceras sp. (proteiforme Hall?).

VERMES.

Cornulites sterlingensis (Meek and Worthen).
Nereidavus varians Grinnell.

CRUSTACEA.

Aparchites minutissimus (Hall).
Asaphus gigas DeKay.
" maximus Locke.
Bollia persulcata Ulrich. (c)
Bythocypris cylindrica (Hall).
Calymmene callicephala Green. (c)
Ulrichia nodosa (Ulrich). (c)

POSITION UNCERTAIN.

Arthraria biclavata Miller.
Bythotrephis gracilis Hall.
" gracilis-crassa Hall.
Pasceolus globosus Billings.
Rusophycus bilobatum Vanuxem.

Lower Richmond Fauna.

In addition to the species in the foregoing list, the following occur in the lower Richmond:

SPONGIÆ.

Brachiospongia tuberculata James.
Dystactospongia minima Ulrich.
Hindia sphæroidalis-parva Ulrich.

COELENTERATA.

Calopœcia cribriformis Nicholson.
Columnaria alveolata Goldfuss.
" halli Nicholson.
Labechia ohioensis (Nicholson).
Megalograptus welchi Miller.

ECHINODERMATA.

Compsocrinus harrisi (Miller).
" miamiensis (Miller).
Cyclocystoides magnus Miller and Dyer.
Cyclocystoides minus Miller and Dyer.
Cyclocystoides mundulus Miller and Dyer.
Cyclocystoides parvus Miller and Dyer.
Dendrocrinus caduceus (Hall).
" casei Meek.
" erraticus Miller.
Gaurocrinus cognatus (Miller).
" magnificus Miller.
" nealli (Hall).
Glyptocrinus? fornshelli Miller.
" richardsoni Wetherby.
Heterocrinus juvenis Hall.
Lichenocrinus affinis Miller.
Ohiocrinus oehanus (Ulrich).
Palæaster exculptus Miller.
" harrisi Miller.
" longibrachiatus Miller.
" magnificus Miller.
" miamiensis Miller.
" simplex Miller.
Palæasterina approximata Miller and Dyer.
Palæasterina speciosa Miller and Dyer.
Rhaphanocrinus sculptus(Miller).
Streptaster? septembrachiatus (Miller and Dyer).
Tanaocrinus typus Wachsmuth and Springer.
Tæniaster elegans Miller.
" miamiensis (Miller).
Urasterella grandis (Meek).
Xenocrinus baeri (Meek).
" penicillus Miller.

BRYOZOA.

Amplexopora pustulosa Ulrich.
Arthropora shafferi (Meek), variety.
Atactopora sp.
Atactoporella schucherti Ulrich.
Batostoma varians (James). (c)
Berenicea primitiva Ulrich.
Bythopora delicatula (James). (c)
" meeki (James). (c)
Callopora subnodosa Ulrich.
" sp.
Calloporella circularis (James).
Ceramoporella granulosa Ulrich, variety.
Ceramoporella ohioensis (Nicholson).
Ceramoporella whitei (James).
" sp.
Constellaria limitaris Ulrich.
Eridotrypa simulatrix Ulrich.
Graptodictya perelegans (Ulrich).
Helopora elegans, Ulrich.
" harrisi James.
Heterotrypa subramosa (Ulrich).
Heterotrypa subramosa - prolifica Ulrich.
Homotrypa dawsoni (Nicholson).
" wortheni (James). (c)
" several undescribed species.
Homotrypella sp.
Lioclemella subfusiformis (James)
Monticulipora sp.
Nicholsonella sp.
Pachydictya fenestelliformis (Nicholson).

Paleschara beani (James).
Proboscina frondosa (Nicholson).
Ptilodictya flagellum Nicholson.
" nodosa James.
Rhinidictya lata (Ulrich).
Rhopalonaria venosa Ulrich.
Spatiopora corticans (Nicholson).
" montifera Ulrich.
" tuberculata (Edwards and Haime).
Spatiopora sp.

BRACHIOPODA.

Catazyga headi (Billings).
Dalmanella jugosa James.
Dinorthis scovillei (Miller).
Hebertella insculpta Hall.
Lingula vanhorni Miller.
Platystrophia cypha (James).
Rafinesquina alternata-alternistriata (Hall).
Rhynchotrema capax-perlamellosum (Whitfield).
Strophomena neglecta James.
" nutans Meek.
" subtenta Conrad.
" sulcata (Verneuil).
" vetusta (James).
Trematis quincuncialis Miller and Dyer.

PELECYPODA.

Anomalodonta alata Meek.
" costata James.
" gigantea Miller.
Byssonychia cultrata Ulrich.
" grandis Ulrich.
Corallidomus concentricus Whitfield.
Ctenodonta albertina Ulrich.
" iphigenia Billings.
" similis Ulrich.
Cuneamya curta Whitfield.
" miamiensis Hall and Whitfield.
Cuneamya neglecta Meek.
" scapha Hall and Whitfield.
Cymatonota attenuata Ulrich.
" semistriata Ulrich.
" typicalis Ulrich.
Eridonychia crenata Ulrich.
Lyrodesma major (Ulrich).
Modiolopsis concentrica Hall and Whitfield.
Modiolopsis pholadiformis Hall.
" versaillesensis Miller.
Opisthoptera alternata Ulrich.
Opisthoptera extenuata Ulrich.
" fissicosta Meek.
" laticostata Ulrich.
Orthodesma contractum (Hall).
" curvatum Hall and Whitfield.
Orthodesma cymbula Miller and Faber.
Orthodesma rectum Hall and Whitfield.
Orthodontiscus milleri (Meek).
Psiloconcha elliptica Ulrich.
" grandis Ulrich.
" subrecta Ulrich.
Pterinea corrugata (James).
" subquadrata James.
" welchi James.
Sedgwickia? divaricata Hall and Whitfield.
Sedgwickia? lunulata Whitfield.
Whitella carinata (Meek).
" obliquata Ulrich.
" ohioensis Ulrich.
" quadrangularis (Whitfield).
" subovata Ulrich.
" umbonata Ulrich.

GASTROPODA.

Archinacella rugatina Ulrich.
Conradella dyeri (Hall).
Cyclonema bilix-conicum Miller.
Cyrtolites ornatus Conrad.
Helcionopsis striata Ulrich.
Lophospira perlamellosa Ulrich.
Plethospira striata Ulrich.
Protowarthia morrowensis (Miller and Dyer).
Protowarthia subcompressa Ulrich.
Trochonema madisonense Ulrich.

CEPHALOPODA.

Cyrtoceras faberi James.
" irregulare Wetherby.
Gomphoceras indianense Miller and Faber.
Orthoceras carleyi Hall and Whitfield.
Orthoceras fosteri Miller.
" hallanum Miller.
Trocholites circularis Miller and Dyer.

VERMES.

Spirorbis cincinnatiensis Miller and Dyer.

CRUSTACEA.

Acidaspis onealli Miller.
Beyrichia parallela Ulrich.
Bollia pumila Ulrich.
" regularis (Emmons).
Ceratopsis chambersi-robusta Ulrich.
Ceraurus meekanus Miller.
Dalmanites breviceps Hall.
Drepanella richardsoni (Miller).
Lichas harrisi Miller.
Primitia glabra Ulrich.
" milleri Ulrich.
Tetradella lunatifera Ulrich.
" quadrilirata Hall and Whitfield.
Tetradella quadrilirata-simplex Ulrich.

POSITION UNCERTAIN.

Faberia anomala Miller.
Trichophycus lanosum Miller and Dyer.

Middle Richmond Fauna.

In addition to the species previously given as ranging through the Richmond, the following occur in these beds:

SPONGIÆ.

Streptospongia labyrinthica Ulrich.

COELENTERATA.

Streptelasma divaricans (Nicholson).
Tetradium minus Safford, variety.

ECHINODERMATA.

Dendrocrinus polydactylus (Shumard).
Lepadocrinus moorei (Meek).
Lepidodiscus faberi (Miller).
Lichenocrinus tuberculatus Miller.

BRYOZOA.

Batostoma sp.
Crepipora sp.
Heterotrypa affinis Ulrich.
Homotrypa wortheni (James).
" several undescribed species.
Homotrypella sp.
Leptotrypa stidhami Ulrich.
Lioclemella annulifera (Whitfield).
Mesotrypa patella (Ulrich).
Monticulipora lævis Ulrich.
" lævis - consimilis Ulrich.
Monticulipora parasitica Ulrich.
" sp.
Ptilodictya magnifica Miller.
" plumaria James.

BRACHIOPODA.

Dinorthis subquadrata Hall.
Leptæna rhomboidalis (Wilckens).
Platystrophia acutilirata (Conrad). (c)
Rhynchotrema dentatum (Hall). (c)
Strophomena rugosa Blainville.

PELECYPODA.

Anoptera miseneri Ulrich.
Byssonychia obesa Ulrich.
" richmondensis Ulrich.
" robusta (Miller).
" subrecta Ulrich.
" tenuistriata Ulrich.
Clionychia excavata Ulrich.
Ctenodonta hilli (Miller).
Cyrtodonta cuneata (Miller).
" halli Nettleroth.
Ischyrodonta decipiens Ulrich.
" elongata Ulrich.
Ischyrodonta miseneri Ulrich.
" modioliformis Ulrich.
" ovalis Ulrich.
" truncata Ulrich.
Opisthoptera obliqua Ulrich.
Orthodesma subangulatum Ulrich.
Modiolodon declivis Ulrich.
" subrectus Ulrich.
Rhytimya byrnesi (Miller).
Sphenolium cuneiforme (Miller).
" richmondense Miller.

GASTROPODA.

Archinacella indianensis (Miller).
" richmondensis Ulrich.
Bellerophon mohri Miller.
" subangularis Ulrich.
Bucania crassa Ulrich.
" gorbyi (Miller).
" simulatrix Ulrich.
Helicotoma marginata Ulrich.
Lophospira acuminata Ulrich.
" ampla Ulrich.
Oxydiscus magnus (Miller).
Raphistoma richmondense Ulrich.
Salpingostoma richmondense Ulrich.
Tentaculites richmondensis Miller

CEPHALOPODA.

Cyrtoceras amœnum Miller.
" lysander Billings.
Gomphoceras eos Hall and Whitfield.
Gyroceras baeri (Meek and Worthen).

POSITION UNCERTAIN.

Solenopora compacta (Billings).
Strephochetus richmondensis Miller.

Upper Richmond Fauna.

Almost nothing is known as yet of these beds, their thickness, distribution, and fossil contents. The list here given is, therefore, probably, very incomplete. Some of the forms given in the list of those ranging through the Richmond occur in these beds, but perhaps not all given in that list. Some of those in the following list may belong to lower beds:

SPONGIÆ.

Heterospongia aspera Ulrich.
" knotti Ulrich.
Heterospongia subramosa Ulrich.

CŒLENTERATA.

Beatricea nodulosa Billings.
" undulata Billings.
Columnaria alveolata Goldfuss.
Labechia montifera Ulrich.
" ohioensis Nicholson.

BRACHIOPODA.

Zygospira kentuckyensis James.

PELECYPODA.

Ctenodonta cingulata (Ulrich).
Opisthoptera casei (Meek and Worthen).

GASTROPODA.

Lophospira ampla Ulrich.

CEPHALOPODA.

Cyrtocerina madisonensis Miller.

CRUSTACEA.

Entomis madisonensis Ulrich.
Eurychilina striatomarginata (Miller).
Isochilina subnodosa Ulrich, variety.
Jonesella digitata Ulrich.
Leperditia cæcigena Miller.
Primitia medialis Ulrich.

3. LIST OF LOCALITIES.

For the convenience of students and collectors a list is here given of exposures in the city of Cincinnati, and immediate vicinity, where the various beds may be studied and their fossils collected. The list is not exhaustive. Other exposures of greater or less extent may be found. Grading and other improvements are continually affording new exposures, but from becoming overgrown and other causes, dumps, and even cuts are in a few years spoiled for geological purposes. All the strata have been exposed at one time or another, but not all are now exposed. The list given must be regarded, at best, as but temporary. On the map (Plate I), the location of these exposures has been indicated, the abbreviations being placed as nearly as possible upon the exact locations. The map is a partial reproduction of a part of the Cincinnati sheet of the Topographic Map of the U. S. Geological Survey.

TRENTON PERIOD.

The principal exposures are on the south bank of the Ohio from West Covington to Ludlow; at the mouth of the Licking River (Covington side); two outcrops on the west bank of the Licking River in Covington; several small streams flowing into the Licking south of Newport and Covington, cut into the Trenton as well as afford exposures of the lower Utica strata; dèbris from Trenton strata has been thrown out in excavating the new water-works tunnels; the south bank of the Ohio River in the vicinity of Fort Thomas shows the Trenton outcropping; several quarries, now abandoned, on the road between New Richmond and Point Pleasant, in Clermont County, Ohio, have been opened in Trenton strata.

CINCINNATI PERIOD.

Utica Group.

Lower Utica.—The lowest strata of the Utica may be found in the north bank of the Ohio in the First Ward (Fulton), and in the south bank of the Ohio overlying the Trenton

between West Covington and Ludlow, but the exposures are seldom satisfactory; the same strata may be seen overlying the Trenton in the Ohio River bank near Fort Thomas. Strata somewhat higher have been cut into along the line of the Ludlow cars in West Covington, where the car line leaves the river bank; also in a grading two or three blocks south from the old "Post & Co. factory," on the south bank of the Ohio, near Ludlow. The strata overlying these may be seen in a creek south of Lexington Pike, shortly after leaving Covington, near the "elbow;" probably, also, in other streams, but the fossils can seldom be had without "digging" for them. Many of the more delicate forms can be obtained in no other way.

Middle Utica.—The middle and upper Utica are exposed along the line of the Elberon Avenue cars in Sedamsville; in Fairmount, on Shadwell Street, one block south of Westwood Avenue; in West Fork and its branches, west of Cumminsville; in Economy or West Covington, a block or two distant from the line of the Ludlow cars; at Cote Brilliante, in the southeastern part of Newport, Kentucky; at two or three points along the line of the Monmouth cars south of Newport; and at several points along the line of the Fort Thomas cars.

Upper Utica.—Abuts on Clifton Avenue, under the Elm-Street Incline Plane; across the valley, north from Dixmyth Avenue, in West Clifton, is a good exposure; occasional exposures also occur at other points in Clifton; West Fork and some of its branches, west of Cumminsville, expose the upper Utica; also the hillsides south of Newport and Covington show these strata at several places.

LORRAINE GROUP.

Mt. Hope Beds.—The best exposures known to the writer are near Mt. Hope Road, on the southeastern slope of Price Hill, and on Mitchell Avenue, in Avondale, near Rose Hill Park. They may also be seen on Clifton Avenue, near the Elm-Street Incline Plane, and in the quarry on the hill nearest the Licking, immediately south of Newport.

Fairmount Beds.—These are the beds usually opened in quarries. The fossils are generally obtained by hunting over the "dumps." Quarries are found on Price Hill near Elberon Avenue, and near Mt. Hope Road; in Fairmount; in North Fairmount; on Robert Avenue, Westwood; on the north side of Fairview hill; on Clifton Avenue opposite Burnet Woods Park; on Madison Avenue, Walnut Hills; on the east side of Reading Road or Hunt Street, south of McMillan Street; on the hillsides south of Newport and Covington; near St. Johns Park; on the hillside east of Madisonville.

Bellevue Beds.—These strata may be seen projecting near the top of the hill at the Fairview Incline Plane; near the top of the bluff on Clifton Avenue, just north of the bend, not far from the Elm-Street Incline Plane; on Clifton Avenue opposite Burnet Woods Park; and on Francisco Street in Walnut Hills.

Corryville Beds.—Small exposures are found at several places on Price Hill; a number of exposures may be seen on Fairview Heights, within two or three blocks of the Fairview Incline Plane; also on the north side of McMillan Street, east of Fairview Avenue; and on McMillan Street east of Reading Road.

Mt. Auburn Beds.—The street just east of the Water Tanks on Price Hill (Grand Avenue) has been cut through these beds; they are also exposed at and near the corner of Calhoun Street and Clifton Avenue.

Warren Beds.—These beds are not exposed at or near Cincinnati. Streams in the vicinity of Lebanon and Oregonia, Ohio, afford typical exposures.

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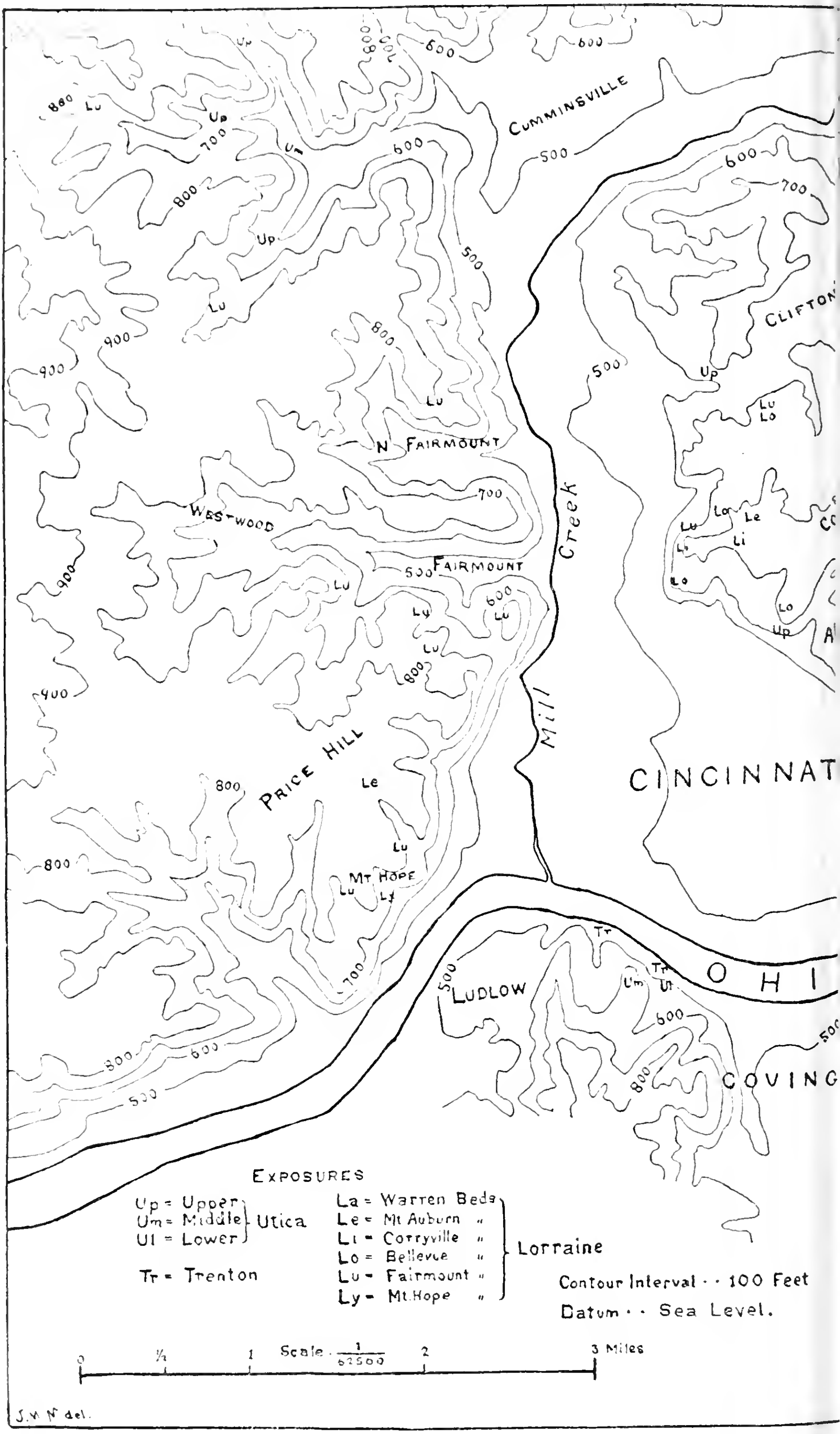

Cumminsville
Clifton
N Fairmount
Westwood
Fairmount
Mill Creek
Price Hill
Mt Hope
Cincinnat
Ludlow
Coving
Ohi
Exposures
Up = Upper
Um = Middle
Ul = Lower
Utica
Tr = Trenton
La = Warren Beds
Le = Mt Auburn "
Li = Corryville "
Lo = Bellevue "
Lu = Fairmount "
Ly = Mt.Hope "
Lorraine
Contour Interval · · 100 Feet
Datum · · Sea Level.
Scale $\frac{1}{62500}$
0 ½ 1 2 3 Miles
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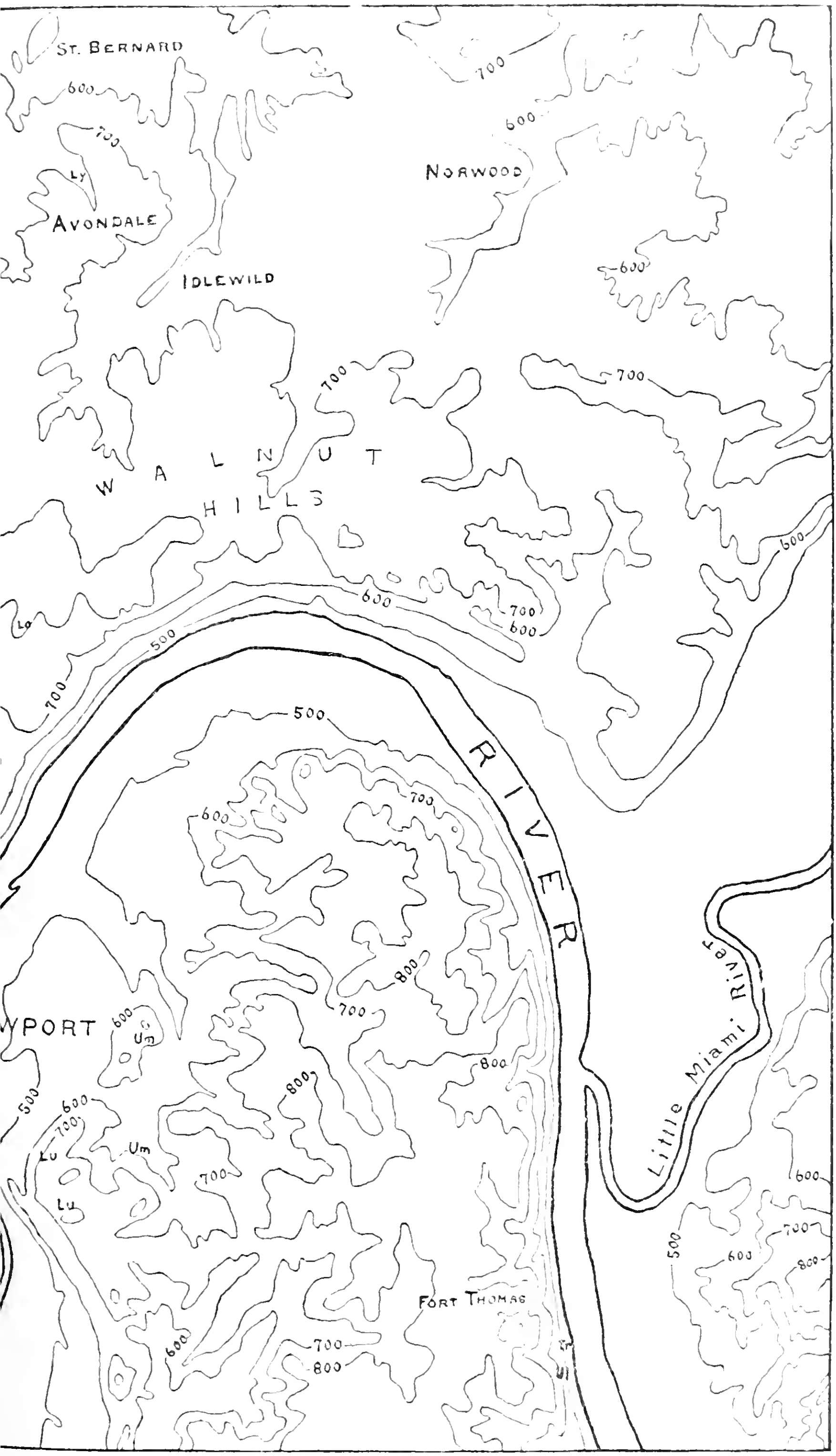

ST. BERNARD
600
700
LY
AVONDALE
IDLEWILD
700
600
NORWOOD
600
700
700
W A L N U T
H I L L S
600
700
600
600
Lo
500
700
500
RIVER
700
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800
700
Little Miami River
YPORT
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Um
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800
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Lu
Um
Lu
700
600
500
700
600
800
FORT THOMAS
600
700
800

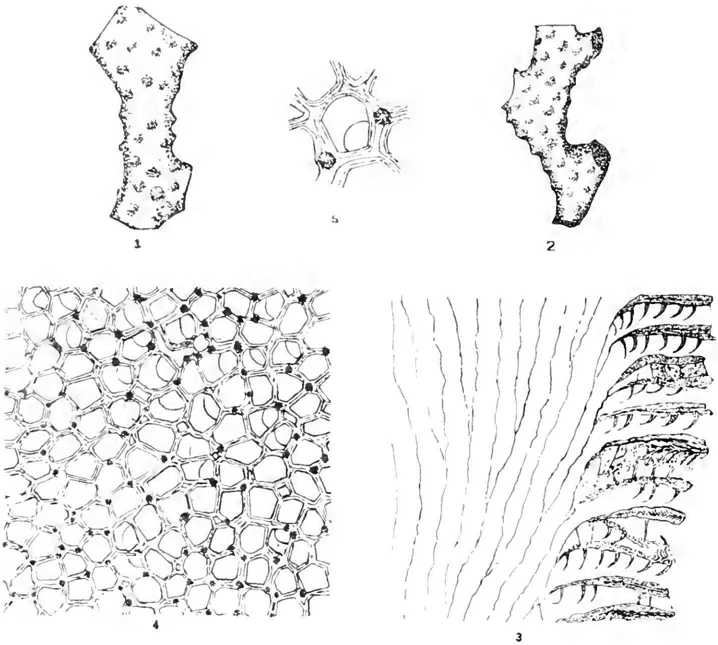
ARTICLE IV.—DESCRIPTION OF A NEW BRYOZOAN, "HOMOTRYPA BASSLERI" n. sp., FROM THE WARREN BEDS OF THE LORRAINE GROUP.

By John M. Nickles.

Homotrypa bassleri n. sp.

Zoarium dwarfish in habit of growth, consisting of flattened, branching fronds, which have gradually expanded from almost cylindrical stems without increasing any in thickness. No specimens showing basal portion or mode of attachment have been observed. Branches usually given off in the same plane as the frond, oftenest by bifurcation, though they are sometimes given off from the side. Examples used in preparing this description, none of them complete, vary from 15 to 32 mm. in height, from 5 to 9 mm. in width, and are about 3 mm. in thickness. Surface studded with low, rounded monticules, a little over one mm. in diameter, and from one to two mm. apart; rarely the monticules are almost obsolete. Apertures rather small, 9 or 10 in 2 mm., subcircular or subangular, often a little oblique to the surface; on the monticules the apertures, as is commonly the case, are a trifle larger than the others. In the axial region the zoœcia have very thin walls, rather less flexuous and crinkled than is the rule in this genus; the zoœcia bend rather abruptly to the peripheral region, where they have their walls much thickened; after making the turn they proceed at right angles to the surface in some specimens, in others a little obliquely. No diaphragms developed in the axial region and but very few in the mature region. Cystiphragms line the upper side of the zoœcia in a single row in the peripheral region, their walls attenuating toward the back, indicating that in the living state calcification was more or less incomplete. The arrangement of the layers forming the walls is well shown in the enlarged view of a tangential section of a single cell, Figure 5, which shows also the appearance of the cystiphragms when cut across, and the structure of the

acanthopores. Acanthopores about twice as numerous as the cells, not conspicuous; few specimens show them on the surface. A small number of irregular, angular interspaces simulating mesopores are seen in tangential sections and also on the surface.



Figures 1 and 2.—Natural size views of two rather large examples, neither complete. Figure 3.—Portion of a vertical section, × 20. Figure 4.—Portion of a tangential section, × 20. Figure 5.—A tangential section of a single zoœcium, showing wall structure and structure of acanthopores, × 40.

This species is so readily distinguished by its small, dwarfish, flattened growth, tuberculated surface and small apertures from all bryozoa found associated in the same beds, and from other species of the genus hitherto described, that detailed comparison seems unnecessary. It belongs to a section of the genus *Homotrypa*, which attains a wide development in the Richmond group.

It seems a little singular that the genus *Homotrypa*, while well represented in the various groups of the Trenton period, is practically lacking in the Utica and sparingly developed in the Lorraine, with from one to three characteristic species in each of its divisions, except the lowest; in the Richmond the genus becomes very prolific in species. A very large number of new species, principally from the Richmond, are known that await description.

This species was discovered by the writer while collecting fossils in company with Messrs. E. O. Ulrich and R. S. Bassler, in June, 1899, in the vicinity of Oregonia and Lebanon, Ohio. It was at this time, also, that it was recognized that these beds form the highest division of the Lorraine. While not ranging entirely through the Warren beds of the Lorraine group, this species is one of the most characteristic fossils of these beds, and is restricted to them.

The specific name is given in honor of my esteemed friend and former co-worker, Mr. R. S. Bassler, now of the U. S. National Museum.

Formation and locality: A common and characteristic species of the Warren beds which form the uppermost division of the Lorraine group of the Cincinnati period. The specimens studied were collected in the vicinity of Lebanon, Ohio, and near Oregonia, Ohio.

ARTICLE V.—A REVISED LIST OF THE COLEOPTERA OBSERVED NEAR CINCINNATI, OHIO,

WITH NOTES ON LOCALITIES, BIBLIOGRAPHICAL REFERENCES, AND DESCRIPTION OF NEW SPECIES.

By Charles Dury.

In this journal, October, 1879, I published a list of the Coleoptera observed in the vicinity of Cincinnati, enumerating 1,419 species. In supplemental papers (1882) added 179 species. Long continued and more careful collecting has revealed many other, rare and interesting forms. Changes in environment that have taken place, have caused many species to become rare or disappear altogether, while some new to the locality have been introduced. Conspicuous among these are the destructive "clover root beetle" (*Phytonomus punctatus*) and the "pea green Diabrotica" (*Diabrotica longicornis*), etc. Some others that are perhaps beneficial have also made their appearance, among which may be mentioned the large showy "Lady bugs" *Coccinella* (*Neoharmonia*) *venusta* and *notulata*.

The area covered in making the collections, on which this list is based, is the same as that given in former list mentioned above. The twenty-three years that have elapsed since that publication has wrought great changes in the local collectors of Coleoptera, all, save one, having either gone to their last resting places or removed from the state. But few new workers in this interesting order have come into the field. Annette Braun, with mother and sister, have made a very fine collection of local insects and added some rare species to the fauna of the locality. Their well prepared material can not be surpassed. Our dear, old friend, Dr. Geo. H. Horn, of Philadelphia, died November 25, 1897. His loss was a calamity severely felt by students of North American Coleoptera. His many excellent papers and the thousands of specimens gratuitously determined by him for others, bear testimony to the vast amount of work done by this unassuming and talented gentleman. And all this accomplished in moments snatched from a busy professional life, actuated only by love of the science.

Four hundred and forty-eight of this list were originally described by Thos. Say, the pioneer entomologist who lived at New Harmony, Ind., the faunæ of Cincinnati and of that place being almost identical. I can not too strongly urge our young people to study the insects, or some other branch of Nature's creatures.

Her methods are so fascinating and wonderful. As I look back over the past thirty years, much of which time has been spent in fields and woods, it brings back only one regret, and that is, that I can not go over it all again. It has been one long round of health-giving pleasure. Our beautiful woodland, with its wealth of varied bird, insect and plant life, is a revelation to those whose eyes become trained to see and understand nature's beauties. During the warmer months the forest is alive with insects, all striving to accomplish the great purpose with which they are endowed, the perpetuation of the species. Many of them employing the most intelligent and cunning devices to accomplish this end.

In answer to the often repeated question "what books shall I get to help in a study of Coleoptera," I enumerate some of those which I have found most useful. The word "*Trans.*," often used, refers to the Transactions of the American Entomological Society of Philadelphia. Such papers as are not out of print can be furnished by the Academy of Natural Sciences, Philadelphia. Some general works that are very desirable to students are classification of the "Coleoptera of North America," and "Rhyncophora," by LeConte and Horn; Packard's "Guide to the Study of Insects;" Comstock's "Manual;" papers on North American Coleoptera, by Maj. Thos. L. Casey, published in annals of New York Academy of Sciences, and New York Entomological Soc.; "Fifth Annual Report of the Entomologist of Minn.," by our lamented friend Prof. Lugger (his reports on the other orders are very valuable also).

This list enumerates 64 families, 828 genera and 1,888 species, and describes 6 new ones.

CINCINDELIDÆ.

"Tiger Beetles."

TETRACHA.

T. virginica *Linn.*

CICINDELA.

C. unipunctata *Fab.*
C. sexguttata *Fab.*
C. purpurea *Oliv.*
C. formosa *Say.*
C. generosa *Dej.*
C. vulgaris *Say.*
C. repanda *Dej.*
C. hirticollis *Say.*
C. punctulata *Fab.*
C. cuprascens *Lec.*
C. marginipennis *Dej.*

C. purpurea was taken here years ago, and again recently. I never saw *Tetracha virginica* here, until 1899. June 28, 1900, they were flying and running about under the electric lights by

hundreds. Bull, Brooklyn Ent. Soc., 1883, p. 77, says of this species: "winged, but does not fly." It does fly nevertheless. They occur here from June to October 2.

C. marginipennis was never observed here until May 17, 1899, when about 25 were taken near Batavia Junction, on a sand bar of the Little Miami river.

C. cuprascens occurs on the sand bars of the Ohio river in vast numbers. *C. unipunctata* and *C. sexguttata* live in the woods. *C. generosa* and *C. formosa* occur in sand pits. *C. punctulata* occurs everywhere. Most of the others are found along sandy flats and banks of streams. They are very active, and a good net is required to effect their capture. For a Monograph of Cicindelidæ see Bulletin Brooklyn Entomological Soc., Nov., 1883, and Revision of the Cicindelidæ of Boreal America, by Chas. W. Leng, Trans. xxviii, 1902, p. 93. This exhaustive and complete paper just received. Every student should have a copy.

CARABIDÆ.

"Rapacious Ground Beetles."

OMOPHRON.

O. robustum *Horn.*
O. americanum *Dej.*
O. tessellatum *Say.*

The sandy shores of Mill Creek was the home of these curious little bettles; hundreds could be secured by throwing water over the sloping banks, when Omophron, with many other small beetles, would emerge and run up the banks, some of the Carabidæ and Heteroceridæ instantly taking flight. Omophron however do not fly and were easily captured. On July 10, 1878, I took 365, divided as follows, 180 *O. tessellatum*, 147 *O. robustum*, and 38 *O. americanum*. Then, Mill Creek was clean, with sandy banks and pebbly bottom. Now it has become a vile open sewer, the sand is saturated with sewage, which decays and gives off deadly gases, destroying all fish and insect life. For synoptic table of Omophron see Bull, Brooklyn Ent. Soc., 1878, p. 71.

CYCHRUS.

C. stenostomus *Web.*
C. lecontei *Dej.*
C. canadensis *Chd.*
C. elevatus var. heros *Harr.*
C. andrewsii *Bland.*

All Cychrus have become rare here. I have not seen *C. andrewsii* or *C. heros* for years. C. heros, when living is one of the most beautiful of the genus, its rich, purple color and graceful form renders it very conspicuous. We trapped many *C. heros* by placing flat stones along the edge of woods, finding the beetles concealed beneath.

CARABUS.

C. limbatus *Say*.

C. vinctus *Web*.

CALOSOMA.

C. externum *Say*.

C. scrutator *Fab*.

C. wilcoxi *Lec*.

C. sayii *Dej*.

C. calidum *Fab*.

C. sayii is rare here, the others common. The electric lights attract great numbers of these useful beetles, many of which are crushed and otherwise destroyed. During May, 1902, *C. scrutator* was abundant, feeding on "canker worms."

ELAPHRUS.

E. ruscarius *Linn*.

Found about wet places, where it runs over the moist ground.

NOTIOPHILUS.

N. semistriatus *Say*.

N. sibericus *Mots*.

Notiophilus lives under moist decaying leaves. Alongside of an old barn I took hundreds of these active beetles. They were concealed under rubbish and fallen grass.

NEBRIA.

N. pallipes *Say*.

PASIMACHUS.

P. elongatus *Lec*.

P. punctulatus *Hald*.

SCARITES.

S. subterraneus *Fab*.

DYSCHIRIUS.

D. hæmorrhoidalis *Dej*.

D. longulus *Lec*.

D. globulosus *Say*.

D. sphæricollis *Say*.

D. erythrocerus *Lec*.

D. brevispinus *Lec*.

D. hispidus *Lec*.

Dyschirius are abundant, if looked for along the sandy shores of streams and will come out when water is thrown over the sand.

CLIVINA.

C. dentipes *Dej*.

C. impressifrons *Lec*.

C. collaris *Hbst*.

C. bipunctata *Fabr*.

C. postica *Lec*.

C. rubicunda *Lec*.

SCHIZOGENIUS.

S. lineolatus *Say*.

S. ferrugineus *Putz*.

ARDISTOMIS.

A. viridis *Say.* A. puncticollis *Putz.*

The last three genera, like Dyschirius, can be found abundantly along the shores of rivers and creeks.

PANAGEUS.

P. crucigerus *Say.* P. fasciatus *Say.*

Both species were always rare here. Have taken them hiding under drift-wood on bank of Ohio river.

BEMBIDIUM.

B. lævigatum *Say.*
B. inæquale *Say.*
B. punctatostriatum *Say.*
B. coxendix *Say.*
B. confusum *Hayward.*
B. americanum *Dej.*
B. honestum *Say.*
B. chalceum *Dej.*
B. nigrum *Say.*
B. picipes *Kby.*
B. cordatum *Lec.*
B. dorsale *Say.*
B. variegatum *Say.*
B. intermedium *Kby.*
B. versicolor *Lec.*
B. quadrimaculatum *Linn.*
B. affine *Say.*

The Bembidium are abundant along the shores of streams. They are active little things, running rapidly when disturbed, quickly hiding under stones or in cracks in the ground. The species are rather difficult to separate unless named types are available for comparison. The latest paper on the genus is one by Roland Hayward: Trans. Amer. Ent. Soc., vol. XXIV, p. 4.

ANILLUS.

A. fortis *Horn.*

I have only taken a single specimen of this minute, pale, eyeless carabid. It was under a flat stone, where a colony of pale ants had their nest. A cluster of *Microcyptus testaceus* were also present in the nest.

TACHYS.

T. scitulus *Lec.*
T. nanus *Gyll.*
T. flavicaudus *Say.*
T. tripunctatus *Say.*
T. ferrugineus *Dej.*
T. granarius *Dej.*
T. lævis *Say.*
T. incurvus *Say.*
T. vivax *Lec.*
T. xanthopus *Dej.*
T. dolosus *Lec.*

Tachys are found in various places, under bark, in decaying wood, along the shores of streams, etc. *T. laevis* is the smallest carabid I have taken here, being only 2.75 mm. long. The latest paper on the genus is by R. Hayward: Trans. Amer. Ent. Soc., vol. XXVI, p. 191.

PERICOMPSUS.

P. sellatus *Lec.*

PATROBUS.

P. longicornis *Say.*

ZUPHIUM.

Z. americanum *Dej.*

TETRAGONODERUS.

T. fasciatus *Hald.*

LEBIA.

L. grandis *Hentz.*
L. atriventris *Say.*
L. pulchella *Dej.*
L. viridis *Say.*
L. pumila *Dej.*
L. viridipennis *Dej.*
L. lobulata *Lec.*
L. ornata *Say.*
L. analis *Dej.*
L. fuscata *Dej.*
L. abdominalis *Chd.*
L. scapularis *Dej.*
L. vittata *Fab.*

COPTODERA.

C. ærata *Dej.*

This species is always found under the loose bark of trees and not beaten from vegetation as are many of the Lebia.

DROMIUS.

D. piceus *Dej.*
D. quadricollis *Lec.*

BLECHRUS.

B. pusio *Lec.*

CALLIDA.

C. punctata *Lec.*

PLOCHIONUS.

P. timidus *Hald.*

MYAS.

M. coracinus *Say.*
M. cyanescens *Dej.*

I never found either of these pretty blue species abundantly, of the first about eight, and the second only one, in over twenty-five years collecting.

PTEROSTICHUS.

P. adoxus *Say.*
P. obsoletus *Say.*
P. honestus *Say.*
P. obscurus *Say.*
P. femoralis *Kby.*
P. rostratus *Newm.*
P. stygicus *Say.*
P. permundus *Say.*
P. sayii *Brulle.*
P. tartaricus *Say.*

P. lacrymosus *Newm.*
P. coracinus *Newm.*
P. lucublandus *Say.*
P. mutus *Say.*

The species of *Pterostichus* are quite difficult to separate. This is particularly the case with the black species, where the series is large. For a synopsis of the genus see Bull. Brooklyn Ent. Soc., 1882, vol. v.

EVARTHRUS.

E. seximpressus *Lec.*
E. sigillatus *Say.*
E. americanus *Dej.*
E. acutus *Lec.*
E. sodalis *Lec.*
E. furtivus *Lec.*

AMARA.

A. avida *Say.*
A. furtiva *Say.*
A. exarata *Dej.*
A. angustata *Say.*
A. impuncticollis *Say.*
A. cupreolata *Putz*
A. fallax *Lec.*
A. polita *Lec.*
A. interstitialis *Dej.*
A. terrestris *Lec.*
A. musculus *Say.*

To identify the species of *Amara* see synoptic table by Horn: Trans., 1875, vol. v, p. 127-8. They are a difficult group.

LOXANDRUS.

L. erraticus *Dej.*
L. minor *Chd.*

Loxandrus, for some unknown reason, is exceedingly rare here. I have only taken three or four specimens in many years. When fresh, some of the species have a beautiful "mother of pearl" iridescence.

DICÆLUS.

D. dilatatus *Say.*
D. purpuratus *Bon.*
D. sculptilis *Say.*
D. furvus *Dej.*
D. ovalis *Lec.*
D. elongatus *Bon.*
D. teter *Bon.*
D. politus *Dej.*

Dicælus are large and common beetles, easily separated. See synoptic table by Horn: Bull. Brooklyn Ent. Soc., 1880, vol. III, pp. 51-52.

CALATHUS.

C. gregarius *Say.*
C. opaculus *Lec.*

PLATYNUS.

P. caudatus *Lec.*
P. hypolithus *Say.*
P. sinuatus *Dej.*
P. extensicollis *Say.*
P. viridis *Lec.*
P. ferreus *Hald.*
P. melanarius *Dej.*
P. crenistriatus *Lec.*
P. rubripes *Zimm.*
P. punctiformis *Say.*
P. ruficornis *Lec.*
P. octopunctatus *Fab.*
P. placidus *Say.*
P. excavatus *Dej.*

P. atratus *Lec.*
P. obsoletus *Say.*
P. variolatus *Lec.*
P. æruginosus *Dej.*

The *Platynus* are more or less abundant, except *P. caudatus.* Of this odd looking species, only one specimen has ever been taken here, and that was found by Dr. J. M. Crawford on the shore of a creek, under a stone.

OLISTHOPUS.

O. parmatus *Say.*

PERIGONA.

P. nigriceps *Dej.*

EUPHORTICUS.

E. pubescens *Dej.*

ATRANUS.

A. pubescens *Dej.*

LEPTOTRACHELUS.

L. dorsalis *Fab.*

CASNONIA.

C. pennsylvanica *Linn.*

GALERITA.

G. janus *Fab.*
G. bicolor *Drury.*

PINACODERA.

P. limbata *Dej.*

CYMINDIS.

C. americana *Dej.*
C. pilosa *Say.*

APENES.

A. lucidula *Dej.*
A. sinuata *Say.*

HELLUOMORPHA.

H. præusta *Dej.*
H. bicolor *Harr.*

BRACHYNUS.

B. americanus *Lec.*
B. fumans *Fab.*
B. perplexus *Dej.*
B. cordicollis *Dej.*

CHLÆNIUS.

C. erythropus *Germ.*
C. sericeus *Forst.*
C. diffinis *Chd.*
C. prasinus *Dej.*
C. leucoscelis *Cher.*
C. nemoralis *Say.*
C. tricolor *Dej.*
C. brevilabris *Lec.*
C. pennsylvanicus *Say.*
C. impunctifrons *Say.*
C. tomentosus *Say.*

ANOMOGLOSSUS.

A. emarginatus *Say*.

A. pusillus *Say*.

BRACHYLOBUS.

B. lithophilus *Say*.

OODES.

O. cupreus *Chd*.

O. 14 striatus *Chd*.

GEOPINUS.

G. incrassatus *Dej*.

This species burrows deeply in the sand, where it lives. I have trapped them by laying a flat board on the sand, and in wet weather they come to the surface, and hide under the board.

CRATACANTHUS.

C. dubius *Beauv*.

AGONODERUS.

A. lineola *Fab*.
A. infuscatus *Dej*.
A. pallipes *Fab*.
A. partiarius *Say*.
A. indistinctus *Dej*.
A. testaceus *Dej*.

HARPALUS.

H. dichrous *Dej*.
H. vulpeculus *Say*.
H. caliginosus *Fab*.
H. erraticus *Say*.
H. pennsylvanicus *De G*.
H. longior *Kby*.
H. faunus *Say*.
H. herbivagus *Say*.
H. nitidulus *Chd*.
H. gravis *Lec*.
H. testaceus *Lec*.

During nights of August 6 and 7, 1890, swarms of *H. caliginosus* came into Cincinnati, attracted by the electric lights. The streets and sidewalks were covered in places with their crushed remains.

SELENOPHORUS.

S. gagatinus *Dej*.

S. conjunctus *Say*.

STENOLOPHUS.

S. ochropezus *Say*.

BRADYCELLUS.

B. rupestris *Say*.

TACHYCELLUS.

T. atrimedius *Say*.

T. badiipennis *Hald*.

ANISODACTYLUS.

A. interstitialis *Say*.
A. rusticus *Dej*.
A. carbonarius *Say*.
A. baltimorensis *Say*.
A. piceus *Men*.
A. terminatus *Say*.

A. agricola *Say.*
A. harrisii *Lec.*
A. discoideus *Dej.*
A. nitidipennis *Lec.*
A. lugubris *Dej.*
A. sericeus *Harr.*

Synoptic tables of many of the families of CARABIDÆ can be found in Bulletin of the Brooklyn Ent. Soc. from 1879 to 1882.

HALIPLIDÆ.

"Crawling Water Beetles."

HALIPLUS.

H. punctatus *Aube.*
H. ruficollis *De G.*

CNEMIDOTUS.

C. simplex *Lec.*
C. duodecimpunctatus *Say.*
C. edentulus *Lec.*

These little beetles crawl about over aquatic plants, the bottom of ponds and creeks. They are not nearly as active as the following families. All of the aquatic beetles can be captured by dredging with a strongly made wire net, with small mesh.

DYTISCIDÆ.

HYDROCANTHUS.

H. iricolor *Say.*

LACCOPHILUS.

L. maculosus *Germ.*
L. proximus *Say.*
L. fasciatus *Aube.*

HYDROVATUS.

H. cuspidatus *Germ.*

BIDESSUS.

B. affinis *Say.*
B. lacustris *Say.*
B. undescribed species.

CŒLAMBUS.

C. acaroides *Lec.*
C. turbidus *Lec.*
C. nubilus *Lec.*

HYDROPORUS.

H. concinnus *Lec.*
H. pulcher *Lec.*
H. undulatus *Say.*
H. consimilis *Lec.*
H. modestus *Aube.*

ILYBIUS.

I. biguttatus *Germ.*

COPTOTOMUS.

C. interrogatus *Fab.*

COPELATUS.

C. glyphicus *Say.*

MATUS.

M. bicarinatus *Say.*

AGABUS.

A. stagninus *Say.*
A. tæniolatus *Harr.*
A. semivittatus *Lec.*

I have found this last species feeding on a bit of earth worm, floating in water. Placing my net under the worm, and raising it up, I counted 43 of the beetles.

DYTISCUS.

D. fasciventris *Say.*
D. harrisii *Kby.*
D. hybridus *Aube.*

ACILIUS.

A. semisulcatus *Aube.*
A. fraternus *Harr.*

THERMONECTES.

T. basilaris *Harr.*
T. fasciaticollis *Harr.*

CYBISTER.

C. fimbriolatus *Say.*

GYRINIDÆ.

"Surface Whirligigs."

GYRINUS.

G. confinis *Lec.*
G. lugens *Lec.*
G. analis *Say.*

DINEUTUS.

D. discolor *Aube.*
D. assimilis *Aube.*

HYDROPHILIDÆ.

HELOPHORUS.

H. lineatus *Say.*

HYDROPHILUS.

H. ovatus *H. & G.*
H. glaber *Hbst.*
H. triangularis *Say.*
H. striolatus *Lec.*
H. nimbatus *Say.*

Excepting *Dytiscus harrisii*, the first two are the largest water beetles found here. *H. ovatus* is shorter and broader and has the triangular piece, into which the anterior end of the sternal spine rests, open. *H. triangularis* is very common, and has the triangle mentioned above closed and complete.

HYDROCHARIS.

H. obtusatus *Say.*

BEROSUS.

B. peregrinus *Hbst.*

B. striatus *Say.*

LACCOBIUS.

L. agilis *Rand.*

PHILHYDRUS.

P. nebulosus *Say.*

P. cinctus *Say.*

P. ochraceus *Mels.*

HYDROCOMBUS.

H. maculicollis *Muls.*

H. fimbriatus *Mels.*

HYDROBIUS.

H. globosus *Say.*

H. subcupreus *Say.*

CERCYON.

C. pubescens *Lec.*

C. hæmorhoidale *Fab.*

C. prætextatum *Say.*

PHÆNONOTUM.

P. extricatum *Say.*

MEGASTERNUM.

M. costatum *Lec.*

CRYPTOPLEURUM.

C. vagans *Lec.*

LEPTINIDÆ.

"Mammal Nest Dwellers."

LEPTINUS.

L. testaceus *Muell.*

This curious little flat, pale, eyeless beetle, I have found only in the nests of small mammals, such as field mice, etc. From one nest I took 90 specimens, and many escaped by running away so rapidly I was unable to gather them all. I think they are only guests of the animals, as I have found them in nests that have been long since deserted by the animals. See note, "What I found in nest of field mouse." This Journal, 1892.

SILPHIDÆ.

"Carrion Beetles."

NECROPHORUS.

N. americanus *Oliv.*

N. marginatus *Fab.*

N. sayi *Lap.*
N. tomentosus *Web.*
N. orbicollis *Say.*

These large showy beetles are ill-smelling things, and when pinned, turn dark in drying and lose the bright yellow colors. Their appearance and smell can be much improved in preparing them for the cabinet, by making an opening between the segments and scraping out the soft parts. Then soak them for several days in ether or gasoline, after which fill up with cotton that has been dampened in carbolic acid, alcohol and corrosive sublimate. To secure specimens, place a dead mole, rat or bird in a suitable place, cover up lightly with bark or grass, and visit it daily during June, July, August and September.

SILPHA.

S. surinamensis *Fab.*
S. noveboracensis *Forst.*
S. inæqualis *Fab.*
S. americana *Linn.*

These frequent the same "banquet hall" as the above and require the same treatment. I have observed *S. surinamensis* feeding on the plump maggots of the "Blue fly." They were chewing them up at a lively rate.

NECROPHILUS.

N. pettitii *Horn.*

A rare species I have only found on fungus growing in thick woods.

CHOLEVA.

C. simplex *Say.*
C. clavicornis *Lec.*
C. basillaris *Say.*
C. terminans *Lec.*

These and the next occur on decaying vegetable and animal matter. I have also taken five specimens in nest of a mouse, June 12.

PRIONOCHÆTA.

P. opaca *Say.*

PTOMAPHAGUS.

P. consobrinus *Lec.*
P. parasitus *Lec.*
P. pusio *Lec.*

P. parasitus I find abundantly in the subterranean nests of a large black ant (Camponotus pennsylvanicus). July 21, 1891, I took 35 from a nest in an orchard. This ant makes nests in honeycombed trees and logs, and also in the ground.

COLON.

C. hubbardi *Horn.*
C. undescribed species.

COLENIS.

C. impunctata *Lec.*

LIODES.

L. polita *Lec.*
L. discolor *Melch.*
L. blanchardi *Horn.*
L. obsoleta *Horn.*
L. basilis *Lec.*
L. dichroa *Lec.*

Liodes are abundant in patches of powdery fungus that grows on logs and dead trees.

AGATHIDIUM.

A. oniscoides *Beauv.*
A. exiguum *Melsh.*
A. pulchrum *Lec.*

SCYDMÆNIDÆ.

Minute hairy brown beetles in which the elytra cover the dorsal segments of abdomen.

CHEVROLATIA.

C. amœna *Lec.*

More than twenty years ago, I took one specimen of this exceedingly rare species, and have never ceased hunting for others, whenever an opportunity offered, but without success.

SCYDMÆNUS.

S. cribrarius *Lec.*
S. flavitarsus *Lec.*
S. capillosulus *Lec.*
S. analis *Lec.*
S. clavipes *Say.*
S. salinator *Lec.*
S. bicolor *Schauff.*
S. brevicornis *Say.*

EUMICRUS.

E. motschulskii *Lec.*
E. grossus *Lec.*
E. floridanus *Casey.*

CHOLERUS.

C. zimmermani *Schaum.*

CEPHENNIUM.

C. corporosum *Lec.*

See Le Conte in Proc. Acad., 1852; also, "Coleopterological Notices: VII.", Annals N. Y. Acad. Sciences vol. IX, p. 351, by Maj. Casey.

PSELAPHIDÆ.

Minute brown beetles with the elytra not covering the dorsal abdominal segments. Segments not freely moveable.

ADRANES.

A. lecontei *Brend.*

ATINUS.

A. monilicornis *Brend.*

CEOPHYLLUS.

C. monilis *Lec.*

CEDIUS.

C. zeigleri *Lec.*

C. spinosus *Lec.*

TMESIPHORUS.

T. costalis *Lec.*

T. carinatus *Lec.*

CTENISTES.

C. piceus *Lec.*

C. zimmermani *Lec.*

C. consobrinus *Lec.*

TYRUS.

T. humeralis *Aube.*

TYCHUS.

T. minor *Lec.*

MACHÆRODES.

M. tychoides *Brend.*

VERTICINOTUS.

V. cornutus *Brend.*

BATRISUS.

B. confinis *Lec.*

B. monstrosus *Lec.*

B. ferox *Lec.*

B. frontalis *Lec.*

B. riparius *Say.*

B. globosus *Lec.*

B. nigricans *Lec.*

B. spretus *Lec.*

FARONUS.

F. tolukæ *Lec.*

See note on this species in this Journal, vol. XIX (1898), p. 139.

BRYAXIS.

B. illinoiensis *Brend.*

B. abdominalis *Aube.*

B. gracilis *Casey.*

B. rubicunda *Aube.*

B. congener *Brend.*

RHEXIUS.

R. insculptus *Lec.*

TRIMIUM.

T. parvulum *Lec.*

EUPLECTUS.

E. linearis *Lec.*

E. confluens *Lec.*

E. interruptus *Lec.*

Unless the PSELAPHIDÆ are collected clean and mounted with great care they are not worth much for study. Collect them

dry, draw out the antennæ, then mount on the extreme tip of the finest paper point, with only a speck of good glue. Brendel and Wickham have published a monograph of the family in the natural history bulletin of the Iowa Acad. Sciences. Vol. 1, p. 216. But the beginner who attempts to name his collection, without named types for comparison, from this or any other available literature, will have "rough sledding."

STAPHYLINIDÆ.

"Rove Beetles."

An immense family with diversified forms and colors, that have the elytra short, abdominal segments in most of the species freely moveable.

FALAGRIA.

F. cingulata *Lec.*
F. bilobata *Say.*

HOMALOTA.

H. trimaculata *Er.*
H. lividipennis *Mann.*

ALEOCHARA.

A. lata *Grav.*
A. brachypterus *Fourc.*

PHILOTERMES.

P. pilosus *Kr.*

DINOPSIS.

P. americanus *Kr.*

ACYLOPHORUS.

A. flavicollis *Sack.*
A. pronus *Erx.*

SOMATIUM.

S. claviger *Casey.*

QUEDIUS.

Q. fulgidus *Fab.*
Q. sublimbatus *Makl.*
Q. peregrinus *Grav.*
Q. capucinus *Grav.*
Q. lævigatus *Gyll.*
Q. molochinus *Grav.*

LISTOTROPHUS.

S. cingulatus *Grav.*

CREOPHILUS.

C. villosus *Grav.*

STAPHYLINUS.

S. vulpinus *Nordm.*
S. maculosus *Grav.*
S. mysticus *Er.*
S. femoratus *Fab.*
S. comes *Lec.*
S. cinnamopterus *Grav.*
S. violaceus *Grav.*
S. viridans *Horn.*

OCYPUS.

O. ater *Grav.*

BELONUCHUS.

B. formosus *Grav.*

PHILONTHUS.

P. aeneus *Rossi.*
P. lucidus *Say.*
P. palliatus *Grav.*
P. debilis *Grav.*
P. fusiformis *Melsh.*
P. fulvipes *Fab.*
P. lomatus *Er.*
P. æqualis *Horn.*
P. brunneus *Grav.*
P. cyanipennis *Fab.*
P. blandis *Grav.*
P. baltimorensis *Grav.*
P. apicalis *Say.*
P. confertus *Lec.*

ACTOBIUS.

A. sobrinus *Er.*
A. pæderoides *Lec.*
A. terminalis *Lec.*

XANTHOLINUS.

X. cephalus *Say.*
X. emmesus *Grav.*
X. obscurus *Er.*

LEPTACINUS.

L. longicollis *Lec.*
L. ruficollis *Lec.*
L. dimidiatus *Say.*
L. umbripennis *Fauv.*

DIOCHUS.

D. schaumii *Kr.*

STENUS.

S. bipunctatus *Er.*
S. egenus *Er.*
S. flavicornis *Er.*
S. annularis *Er.*
S. humilis *Er.*
S. artus *Csy.*
S. argus *Grav.*

EUÆSTHETUS.

E. floridæ *Casey.*

CRYPTOBIUM.

C. badium *Grav.*
C. bicolor *Grav.*
C. texanum *Lec.*
C. pallipes *Grav.*
C. latebricola *Nordm.*

LATHROBIUM.

L. punctulatum *Lec.*
L. armatum *Say.*
L. longiusculum *Grav.*
C. collare *Er.*
C. dimidiatum *Say.*

STILICUS.

S. tristis *Melch.*
S. angularis *Lec.*
S. dentatus *Say.*
S. biarmatus *Lec.*

LITHOCHARIS.

L. corticina *Grav.* L. confluens *Say.*

PÆDERUS.

P. littorarius *Grav.*

SUNIUS.

S. binotatus *Say.* S. longiusculus *Mann.*

STILICOPSIS.

S. monstrosa *Lec.*

PINOPHILUS.

P. latipes *Grav.*

PALAMINUS.

P. testaceus *Er.*

MICROCYPTUS.

M. testaceus *Lec.*

Taken in numbers from nest of small black ant, August, 1888.

TACHINUS.

T. memnonius *Grav.*
T. flavipennis *Dej.*
T. luridus *Er.*
T. schwarzi *Horn.*
T. limbatus *Melsh.*
T. pallipes *Grav.*

TACHYPORUS.

T. maculipennis *Lec.*
T. jocosus *Say.*
T. chrysomelinus *Linn.*
T. scitulus *Er.*
T. brunneus *Fab.*

ERCHOMUS.

T. lævis *Lec.*

CONOSOMA.

C. littoreum *Linn.*
C. crassum *Grav.*
C. basale *Er.*
C. opicum *Say.*
C. scriptum *Horn.*

BOLETOBIUS.

B. niger *Grav.*
B. dimidiatus *Er.*
B. intrusus *Horn.*
B. cincticollis *Say.*
B. trinotatus *Er.*
B. cinctus *Grav.*

BRYOPORUS.

B. flavipes *Lec.*

MYCETOPORUS.

M. americanus *Er.*

MEGALOPS.

M. cælatus *Grav.*

OXYPORUS.

O. femoralis *Grav.*
O. vittatus *Grav.*
O. major *Grav.*
O. lateralis *Grav.*
O. stygicus *Say.*

Megalops I always find on the under side of small fungus grown beech logs, May to October. *Oxyporus* feed on the tender parts of fungus belonging to the *Agaricinae* from May to September. *O. stygicus* is our most abundant species and quite variable in size.

OSORIUS.

O. latipes *Grav.*

BLEDIUS.

B. semiferrugineus *Lec.*
B. analis *Lec.*
B. ruficornis *Lec.*
B. emarginatus *Say.*

I find *Osorius* and *Bledius* abundant along rivers on the low damp ground.

PLATYSTETHUS.

P. americanus *Er.*

OXYTELUS.

O. sculptus *Grav.*
O. nitidulus *Grav.*
O. insignitus *Grav.*
O. placusinus *Lec.*

TROGOPHLŒUS.

T. memnonius *Er.*

APOCELLUS.

A. sphæricollis *Say.*

GEODROMICUS.

G. brunneus *Say.*
G. cæsus *Er.*

LESTEVA.

L. pallipes *Lec.*
L. subcarinata *Er.*

TRIGONODEMUS.

T. striatus *Lec.*

LATHRIMÆUM.

L. sordidum *Er.*

ALOPHRUM.

A. obtectum *Er.*
A. rotundicolle *Salb.*

PYCNOGLYPTA.

P. lurida *Gyll.*

HOMALIUM.

H. humerosum *Fauv.*

PHOTINUS.

P. atomarius *Er.*

MEGARTHRUS.

M. excisus *Lec.*

GLYPTOMA.

G. costale *Er.*

ELEUSIS.

E. pallidus *Lec.*

SIAGONUM.

S. americanum *Melsh.*

MICROPEPLUS.

M. cribratus *Lec.*

In addition to those enumerated I have many species impossible to identify at this time, some of which are doubtless new.

TRICHOPTERYGIDÆ.

"Feather Wings."

Most of these beetles are exceedingly minute, being the smallest of beetles. It requires a powerful glass to study them. I find only two species, by sifting rubbish. They are:

NOSSIDIUM.

N. americanum *Mots.*

TRICHOPTERYX.

T. haldemanii *Lec.*

SCAPHIDIIDÆ.

Black shining beetles that live on fungus grown logs.

SCAPHIDIUM.

S. quadrimaculatum *Say.* S. quadripustulatum *Say.*
S. obliteratum *Lec.* S. piceum *Melsh.*

S. obliteratum is a form in which the dorsal punctures are nearly obliterated. Dr. Horn considered the last three varieties of the first. Maj. Casey has a synopsis in Journal, N. Y. Ent. Soc., vol. VIII, June, 1900.

CYPARIUM.

C. flavipes *Lec.*

BÆOCERA.

B. concolor *Fab.*

Sifted from field mouse's nest December, 1891.

SCAPHISOMA.

S. convexum *Say.*

TOXIDIUM.

T. compressum *Zimm.*

PHALACRIDÆ.

OLIBRUS.

O. striatulus *Lec.*
O. nitidus *Melsh.*
O. consimilis *Marsh.*

ANCYLOMUS.

A. ergoti *Csy.*

CORYLOPHIDÆ.

Many of this family of small beetles are to be found on the trunks of standing dead trees feeding on a powdery fungus.

SACIUM.

S. obscurum *Lec.*
S. fasciatum *Say.*
S. amabile *Lec.*
S. lunatum *Lec.*

SERICODERUS.

S. obscurus *Lec.*
S. subtilis *Lec.*

COCCINELLIDÆ.

"Lady Bugs" or "Lady Birds."

This is one of the most important families of beetles. Many of the species in the larval form feed on plant lice and scale insects. Their value in ridding vegetation of these pests can hardly be estimated.

Introduced pests can sometimes be controlled by introducing their "Lady bug" parasite. The family is large and all, with few exceptions, feed on other insects. The rapidity with which *Adalia* and *Brachyacantha* will destroy a colony of "plant lice" (*aphidae*) is surprising. Our species are:

MEGILLA.

M. maculata *D. G.*

HIPPODAMIA.

H. glacialis *Fab.*
H. tredecimpunctata *Linn.*
H. convergens *Guer.*
H. parenthesis *Say.*

COCCINELLA.

C. venusta *Melsh.*
C. sanguinea *Linn.*

C. notulata *Muls.*
C. novemnotata *Hbst.*
C. bipunctata *Linn.*
C. pullata *Say.*

I have never observed *C.* (*Neoharmonia*) *venusta* and *C. notulata* here until 1898, in which year I saw one specimen. Since then they are becoming more abundant. I have specimens that seem to prove *notulata* a dimorphic form of *venusta.*

ANATIS.

A. quindecimpunctata *Oliv.*

PSYLLOBORA.

P. vigintimaculata *Say.*

CHILOCORUS.

C. bivulneratus *Muls.*
C. abdominalis *Say.*

CRYPTOGNATHA.

C. pusilla *Lec.*

PENTILIA.

P. misella *Lec.*

BRACHYACANTHA.

B. ursina *Fab.*
B. decempustulata *Melsh.*
B. quadripunctata *Melsh.*

HYPERASPIS.

H. fimbriolata *Melsh.*
H. undulata *Say.*
H. signata *Oliv.*
H. bigeminata *Rand.*

SCYMNUS.

S. bioculatus *Muls.*
S. americanus *Mulls.*
S. hæmorrhous *Lec.*
S. collaris *Melsh.*
S. caudalis *Lec.*
S. tenebrosus *Muls.*
S. punctatus *Melsh.*

CEPHALOSCYMNUS.

C. zimmermani *Cr.*

EPILACHNA.

E. borealis *Fab.*

I have found this last species in clusters under leaves during the winter. With very few exceptions our COCCINELLIDÆ are abundant if searched for at the proper time and place. Crotch published a revision of the family, Trans., vol. IV. 1873, p. 363.

Maj. Thos. L. Casey has published a revision and synopsis in Journal, New York Ent. Soc., vol. VII, No. 2, June, 1899.

ENDOMYCHIDÆ.

SYMBIOTES.

S. ulkei *Cr.*
S. minor *Cr.*

RHANIS.

R. unicolor *Zieg.*

PHYMAPHORA.

P. pulchella *Newm.*

LYCOPERDINA.

L. ferruginea *Lec.*

This last species is common if searched for at the proper place, which is inside the little round fungus *Lycoperdon piriforme*, where it may be found covered with the spores of the fungus. By squeezing the ball the beetle can be felt, if within.

APHORISTA.

A. vittata *Fab.*

MYCETINA.

M. perpulchra *Newm.*

STENOTARSUS.

S. hispidus *Hbst.*

ENDOMYCHUS.

E. bivittatus *Gerst.*

Mycetina and *Aphorista* I have found very early in Spring clinging to the under side of oak rails that were lying along the edge of a woods. The curious and pretty little *Phymaphora* is found on old beech logs. *Symbiotes* occurs on logs where it feeds on the fungus growing there.

For synopsis, see Crotch Trans. vol. IV, 1873, p. 349.

EROTYLIDÆ.

LANGURIA.

L. bicolor *Fab.*
L. mozardi *Lat.*
L. angustata *Bean.*
L. trifasciata *Say.*
L. gracilis *Newm.*

L. trifasciata is considered a variety of *L. angustata*, but I strongly doubt it.

PLŒOSOMA.

P. punctata *Lec.*

DACNE.

D. quadrimaculata *Say.*

MEGALODACNE.

M. fasciata *Fab.*
M. heros *Say.*
M. ulkei *Crotch.*

I have found *ulkei* only on a fungus (*Polyporus cuticularis*), growing on beech logs together with its larvæ. Under favorable conditions they were common during May and June. Thick woods.

ISCHYRUS.

I. quadripunctatus *Oliv.*

MYCOTRETUS.

M. sanguinipennis *Say.* M. pulchra *Say.*

TRITOMA.

T. humeralis *Fab.*
T. biguttatus *Say.*
T. unicolor *Say.*
T. festiva *Lec.*
T. macra *Lec.*
T. thoracica *Say.*
T. flavicollis *Lec.*

Have bred *T. festiva* from fungus found growing on beech stump. The larvæ were voracious feeders, and consumed the entire inner part, leaving a thin shell, which held the piece together. Crotch has a revision. Trans. 1873, vol. IV, p. 349.

COLYDIIDÆ.

SYNCHITA.

L. parvula *Guer.*
L. fuliginosa *Melsh.*
L. granulata *Say.*

CICONES.

C. marginalis *Melsh.*

BITOMA.

B. quadrigutta *Say.* B. quadricollis *Horn.*

EUDESMA.

E. undulata *Melsh.*

This species is rare. It was described by Melsheimer from Penn. For years it remained unique, until one day, while taking refuge under a buckeye log that spanned a ravine, to escape a shower, I looked up and saw some curious little elongated beetles running rapidly up and down the log, and running into round holes in a very colydiid fashion. I gathered six specimens, and when I studied them, found I had this rare insect. Mr. Siewers had taken one specimen under bark of sycamore the year before (1879) in same woods. This beautiful woods is now gone. I have not seen the species since.

CONELUS.

C. guttulatus *Lec.*

LASCONOTUS.

L. pusillus *Lec.*

AULONIUM.

A. parallelopipedum *Say.* A. tuberculatum *Lec.*

COLYDIUM.

C. lineola *Say.*

PENTHELISPA.

P. reflexa *Say.*

PYCNOMERUS.

P. sulcicollis *Lec.*

BOTHRIDERES.

B. geminatus *Say.*

EROTYLATHRIS.

E. exaratus *Melsh.*

I found this nicely sculptured species but once abundantly. It was hatching from cocoons, that its larvæ had constructed under the bark of a dead Elm tree. Many pupa had died in the cocoons evidently from the heat of the sun shinning on the bark.

CERYLON.

C. castaneum *Say.*

PHILOTHERMUS.

P. glabriculus *Lec.*

MYCHOCERUS.

M. depressus *Lec.*

See Dr. Horn's paper on *Colydiidae*, Proc. Amer. Phil. Soc. 1878, Vol. XVII, p. 555.

RHYSSODIDÆ.

RHYSSODES.

R. exarata *Ill.*

CLINIDIUM.

C. sculptile *Newm.*

See synopsis by LeConte Trans., V. 5, 1875, p. 162. There are only four N. A. species in the family. The other two being found in Cal. Ours live under bark of decaying logs, and are abundant.

CUCUJIDÆ.

SYLVANUS.

S. surinamensis *Linn.*
S. bidentatus *Fab.*
S. planatus *Germ.*
S. advena *Waltl.*

NAUSIBIUS.

N. dentatus *Marsh.*

CATOGENUS.

C. rufus *Fab.*

PEDIACUS.

P. depressus *Hbst.*

CUCUJUS.

C. clavipes *Fab.*

INO.

Undescribed species.

I found one specimen of this last genus by beating the dead limbs of honey locust. Mr. Ulke to whom I gave it, said it was new. I never saw another.

LÆMOPHLŒUS.

L. biguttatus *Say.*
L. fasciatus *Melsh.*
L. adustus *Lec.*
L. testaceus *Fab.*
L. convexulus *Lec.*

LATHROPUS.

L. vernalis *Lec.*

BRONTES.

B. dubius*Fab.*
B. debilis *Lec.*

TELEPHANUS.

T. velox *Hald.*

Synopsis by LeConte Proc. Acad. 1854. V. 7. p. 73. The species of this family are very striking examples of forms modified for an existence under the loose close laying bark of trees, enabling them to squeeze into crevices where they find food for their larvæ, and the eternally vigilant ant can not penetrate.

CRYPTOPHAGIDÆ.

LOBERUS.

L. impressus *Lec.*

ANTHEROPHAGUS.

A. ochraceus *Mels.*

CROSIMUS.

C. hirtus *Casey.*

CRYPTOPHAGUS.

C. croceus *Zimm.*
C. nodangulus *Zimm.*

CÆNOSCELIS.

C. subfuscata *Casey.*
C. ferruginea *Sahlb.*
C. elongata *Csy.*
C. obscura *Csy.*

ATOMARIA.

A. crypta *Casey.*
A. ephippiata *Zimm.*

A number of unnamed CRYPTOPHAGIDÆ.

MYCETOPHAGIDÆ.

"Fungus eaters."

MYCETOPHAGUS.

M. punctatus *Say.*
M. flexuosus *Say.*
M. melsheimerii *Lec.*
M. pluripunctatus *Lec.*
M. obsoletus *Melsh.*

PISENUS.

P. humeralis *Kby.*

LITARGUS.

L. 6-punctatus *Say.*
L. balteatus *Lec.*
L. tetraspilotus *Lec.*
L. didesmus *Say.*
L. nebulosus *Lec.*

TYPHÆA.

T. fumata *Linn.*

DIPLOCŒLUS.

D. brunneus *Lec.*

Synopsis by Casey in Journal N. Y. Ent. Soc., June, 1900.

DERMESTIDÆ.

"Museum and household pests."

DERMESTES.

D. lardarius *Linn.*
D. pulcher *Lec.*
D. vulpinus *Fabr.*
D. maculatus *Dej.*

ATTAGENUS.

A. piceus *Oliv.*

TROGODERMA.

T. ornatum *Say.*
T. tarsale *Melsh.*

ANTHRENUS.

A. scrophulariæ *Linn.* A. musæorum *Linn.*
A. varius *Fab.*

CRYPTORHOPALUM.

C. balteatum *Lec.*

ORPHILUS.

O. glabratus *Fab.*

Anthrenus is a terrible pest, and unless the utmost vigilance is exercised they will get into and ruin an insect collection in a short time. The strong fumes of napthaline or crude carbolic acid will disguise the odor of dried insects and repell the pests from the boxes. Strong carbon bi-sulphide fumes will kill *Anthrenus* after they get in. Maj. Casey has a synopsis in Journal N. Y. Ent. Soc., June, 1900.

HISTERIDÆ.

Our species are nearly all black shining beetles that live in excrement and decaying material. Some few species live under bark and are modified for such an existence being flattened and with short legs.

HOLOLEPTA.

H. lucida *Lec.* H. fossularis *Say.*

HISTER.

H. harrisii *Kby.*
H. immunis *Er.*
H. marginicollis *Lec.*
H. fœdatus *Lec.*
H. abbreviatus *Fab.*
H. furtivus *Lec.*
H. incertus *Mars.*
H. servus *Er.*
H. sedecimstriatus *Say.*
H. americanus *Payk.*
H. subrotundus *Say.*
H. vernus *Say.*
H. carolinus *Payk.*
H. lecontei *Mars.*
H. aurelianus *Horn.*
H. coarctatus *Lec.*
H. basalis *Lec.*
H. gracilis *Lec.*

TRIBALUS.

T. americanus *Lec.*

EPIERUS.

E. regularis *Beauv.* E. pulicarius *Er.*

HETÆRIUS.

H. brunneipennis *Rand.*

I have taken this species by digging into the nests of mound building ants (*Formica exsectoides*).

DENDROPHILUS.

D. punctulatus *Say.*

PAROMALUS.

P. æqualis *Say.*
P. estriatus *Lec.*
P. bistriatus *Er.*
P. seminulum *Er.*

SAPRINUS.

S. assimilis *Payk.*
S. fraternus *Say.*
S. fitchii *Mars.*
S. patruelis *Lec.*

TERETRIUS.

T. americanus *Lec.*

BACANIUS.

B. punctiformis *Lec.*

ACRITUS.

A. exiguus *Er.*

AULETES.

A. undescribed species.

NITIDULIDÆ.

"Sap feeders."

Members of this family can be found in quantities, whereever sap exudes from trees, early in the spring. This is particularly the case with maple trees. I have trapped hundreds by laying chips on top of a freshly cut maple stump, where the sap was exuding. Under these chips were congregated 20 species and hundreds of individuals. A mixture of vinegar or sour beer, and brown sugar or molasses, will also attract them, if spread on a log in the woods, and covered with chips.

CERCUS.

C. abdominalis *Er.*

CARPOPHILUS.

C. hemipterus *Linn.*
C. niger *Say.*
C. marginatus *Say.*
C. corticinus *Er.*
C. antiquus *Melsh.*

COLASTUS.

C. morio *Er.*
C. maculatus *Er.*
C. semitectus *Say.*
C. truncatus *Rand.*

CONOTELUS.

C. obscurus *Er.*

EPURÆA.

E. hornii *Cr.*
E. helvola *Er.*
E. rufa *Say.*
E. erichsonii *Reit.*
E. corticina *Er.*
E. rufida *Melsh.*
E. avara *Rand.*
E. fulvescens *Horn.*
E. planulata *Er.*
E. ovata *Horn.*
E. labilis *Er.*

and some unidentified species.

NITIDULA.

N. bipustulata *Linn.*
N. zic zac *Say.*

STELIDOTA.

S. gemminata *Say.*
S. octomaculata *Say.*
S. strigosa *Gyll.*

PROMETOPIA.

P. sexmaculata *Say.*

PHENOLIA.

P. grossa *Fab.*

OMOSITA.

O. colon *Linn.*

SORONIA.

S. undulata *Say.*

POCADIUS.

P. helvolus *Er.*

MELIGETHES.

M. mutatus *Harr.*

OXYCNEMIS.

O. nigripennis *Lec.*
O. histrina *Lec.*

The last two species very much resemble *Histers* and are found in the curious fungus called the "stink horn."

AMPHICROSSUS.

A. ciliatus *Oliv.*

PALLODES.

P. silaceus *Er.*

CYBOCEPHALUS.

C. nigritulus *Lec.*

These minute little beetles are found on fungus grown logs They are sometimes in clusters composed of hundreds of individuals.

CRYPTARCHA.

C. ampla *Er.* C. concinna *Melsh.*

IPS.

I. fasciatus *Oliv.* I. confluentus *Say.*
I. sanguinolentus *Oliv.*

RHIZOPHAGUS.

R. bipunctatus *Say.*

Dr. Horn's paper on this family, Trans., 1879, V. 7, p. 257, is the best synopsis of the North American *Nitidulidae.*

LATHRIDIIDÆ.

A family of minute beetles that live under the bark of trees, in decaying leaves, etc. I collect them by sifting such debris.

LATHRIDIUS.

L. liratus *Lec.*

ENICMUS.

E. maculatus *Lec.* E. aterrimus *Mots.*

CARTODERE.

C. filiformis *Lec.*

CORTICARIA.

C. serrata *Payk.* C. brevicornis *Fall.*

MELANOPHTHALMA.

M. picta *Lec.* M. distinguenda *Com.*
M. cavicollis *Mann.* M. americana *Mann.*

When more careful search for them is made, other species will doubtless be found here. In a deserted nest of our common "wild rabbit" (*Lepus sylvaticus*), I found 31 *Corticaria serrata*, together with what I suppose was their larvæ. They were feeding on the epithelial scales and other debris of the rabbit. With them were two other species. See Revision of Family, by H. C. Fall, "Trans," XXVI, 1899, pp. 101-190.

TROGOSITIDÆ.

Mostly elongate cylindrical or elongate flat species that live under the bark of dead trees.

NEMOSOMA.

N. cylindricum *Lec.*

ALINDRIA.

A. cylindrica*Serv.*

TROGOSITA.

T. virescens *Fab.*

This species has been introduced with logs brought to the saw mills I think.

TENEBRIOIDES.

T. mauritanica *Linn.*
T. castanea *Melsh.*
T. dubia *Melsh.*
T. bimaculata *Melsh.*
T. marginata *Beauv.*

GRYNOCHARIS.

G. 4-lineata *Mels.*

This is a very rare species. I have only taken three.

MONOTOMA.

M. producta *Lec.*
M. fulvipes *Mels.*
M. picipes *Hbst.*

HESPEROBÆNUS.

H. rufipes *Lec.*

EUROPS.

E. pallipennis *Lec.*

BACTRIDIUM.

B. ephippigerum *Guer.*
B. striolatum *Reit.*

DERODONTIDÆ.

Our only species of the family is very abundant in fungi.

DERODONTUS.

D. maculatus *Mels.*

BYRRHIDÆ.

"Pill Beetles."

Some of the genus *Byrrhus*, when they have their pubescence perfect, are a pill the Coleopterist likes to take—— into his bottle. Only two species occur here, they are

NOSODENDRON.

N. unicolor *Say.*

LIMNICHUS.

L. sp.

GEORYSSIDÆ.

Small round coarsely punctured black beetles that live on the

muddy shores of streams. They cover themselves with mud, so they are very difficult to see, consequently but few of our collectors get them. Our only species is

GEORYSSUS.

G. pusillus *Lec.*

PARNIDÆ.

This is an aquatic family, that live submerged in running water, clinging to flat stones or logs. Their larvæ are flat, thin creatures that do not look like the larvæ of an insect. I have found the seven species that we take here, together with the larvæ of some of them, adhering to submerged logs and stones in the swift running water of Mill Creek and the Little Miami river. By taking an old limb or rough stone from the water at a suitable locality and placing it in the sun, the insects will move as the water dries off, although at first nothing can be seen of them, so perfectly do they resemble the surface on which they rest. In Trans., V. 3, 1870, p. 29. Dr. Horn has a synoptic paper on them.

HETEROCERIDÆ.

A family of rather elongate, convex, pubescent, mud colored beetles, that burrow in the mud. The foretibiæ are broad and flattened, enabling the insect to dig out of sight with great celerity. When the mud flat in which they are concealed is shaken or water poured over it, they rush out of their burrows and take flight. Dr. Horn has an admirable paper on the N. A. species in Trans., Vol. XVII, p. 1.

HETEROCERUS.

H. ventralis *Mels.*
H. undatus *Mels.*
H. brunneus *Mels.*
H. collaris *Kies.*
H. pusillus *Say.*

DASCYLLIDÆ.

A family of rather soft texture and small size, variable in color. Some are found on dead timber. One species of *Ectopria,* I have found clinging to a stone submerged in a swift running creek, June 29.

PTILODACTYLA.

P. angustata *Horn.*

EUCINETUS.

E. oviformis *Lec.*
E. morio *Lec.*
E. terminalis *Lec.*

ECTOPRIA.

E. nervosa *Melsh.*

PRIONOCYPHON.

P. discoideus *Say.*

HELODES.

H. pulchella *Guer.*
H. thoracica *Guer.*
H. fuscipennis *Guer.*

SCIRTES.

S. tibialis *Guer.*
S. orbiculatus *Fab.*

CYPHON.

C. ruficollis *Say.*
C. variabilis *Thunb.*
C. obscurus *Guer.*

See Horn's paper, Trans., 1880, V. 8, p. 76.

RHIPICERIDÆ.

ZENOA.

Z. picea *Beauv.*

SANDALUS.

S. niger *Knoch.*
S. petrophya *Knoch.*

For note on life history of *Sandalus niger*, see paper I published in this journal, Vol. XIX, No. 5, p. 172. I do not know of any complete paper up to date, on the N. A. members of this family. Dr. Horn has a synopsis of *Sandalus*, Trans. 1881, Vol. 9, p. 86.

ELATERIDÆ.

This great family is richly represented here. The N. A. species are much in need of a revision to include the new species discovered since Le Conte's paper, Trans. Amer. Philosophical Soc., 1853. N. Series, vol. x, pp. 405-508. The *Eucneminae*, *Cerophytinae* and *Perothopinae* have been done in an admirable manner by Dr. Horn. Trans., January, 1886, pp. 5-58.

The Elaters are popularly known as "Spring beetles," "Click beetles" and "Snapping bugs." Their larvae live mostly in decaying wood and in the ground, on plant roots, and are called "wire worms." The adult beetles are found in a great variety of places, on the trunks and foliage of trees, under bark, and early in the Spring, under stones, on the ground, etc. Our species are:

MELASIS.

M. pectinicornis *Melsh.*

From a beech log about four feet long I took 50 specimens, that were emerging from round holes they had made. May 27, 1892.

THAROPS.

T. ruficornis *Say*.

STETHON.

S. pectorosus *Lec*.

A rare species I found here years ago, feeding on fungus that was growing on the underside of a poplar log. Miss Braun found it under bark, 1901.

EUCNEMIS.

E. americana *Horn*.

Have only seen three specimens, all taken on dead beech.

DELTOMETOPUS.

D. amœnicornis *Say*.
D. rufipes *Mels*.

DROMÆOLUS.

D. cylindricollis *Say*.
D. harringtoni *Horn*.

FORNAX.

F. badius *Melsh*.
F. calceatus *Say*.
F. hornii *Bonv*.
F. molestus *Bonv*.
F. orchesides *Newm*.

ENTOMOPHTHALMUS.

E. rufiolus *Lec*.

MICRORHAGUS.

M. pectinatus *Lec*.
M. audax *Horn*.
M. subsinuatus *Lec*.
M. impressicollis *Bonv*.
M. bonvouloiri *Horn*.
M. humeralis *Say*.
M. triangularis *Say*.

All found running about dead timber in the sunshine, or resting in the crevices later in the day.

HYPOCŒLUS.

H. frontosus *Say*.
H. terminalis *Lec*.

NEMATODES.

N. atropos *Say*.
N. penetrans *Lec*.

The members of the *Eucneminæ* above, have not the power so developed, as have the more typical Elaters, of "snapping," "clicking" or springing up in the air, when laid on their backs.

ADELOCERA.

A. impressicollis *Say*.
A. marmorata *Fab*.
A. discoidea *Web*.
A. aurorata *Lec*.
A. maculata *Lec*.
A. avita *Say*.

CHALCOLEPIDIUS.

C. viridipilis *Say.*

ALAUS.

A. oculatus *Linn.*

HEMIRHIPUS.

H. fascicularis *Fab.*

This large handsome species was taken July 14 at Redbank.

CARDIOPHORUS.

C. convexus *Say.*

See paper by F. Blanchard. Trans., January, 1889.

HORISTONOTUS.

H. curiatus *Say.*

CRYPTOHYPNUS.

C. pulchellus *Linn.*
C. pectoralis *Horn.*
C. obliquatulus *Mels.*
C. perplexus *Horn.*
C. æstivus *Horn.*
C., undescribed species, allied to *C. striatulus.*

ŒDOSTETHUS.

O. femoralis *Lec.*

ANCHASTUS.

A. binus *Say.*

MONOCREPIDIUS.

M. lividus *Dej.*
M. suturalis *Lec.*
M. vespertinus *Fab.*
M. auritus *Hbst.*
M. bellus *Say.*

ISCHIODONTUS.

I. soleatus *Say.*

ELATER.

E. hepaticus *Melsh.*
E. pedalis *Cand.*
E. nigricollis *Hbst.*
E. linteus *Say.*
E. discoideus *Fab.*
E. læsus *Lec.*
E. impolitus *Melsh.*
E. rubricollis *Hbst.*
E. obliquus *Say.*

DRASTERIUS.

D. elegans *Fab.*

MEGAPENTHES.

M. limbalis *Hbst.*

LUDIUS.

L. attenuatus *Say.*
L. abruptus *Say.*

ORTHOSTETHUS.

O. infuscatus *Germ.*

AGRIOTES.

A. mancus *Say.*
A. pubescens *Melsh.*
A. oblongicollis *Melsh.*

GLYPHONYX.

G. recticollis *Say.*
G. testaceus *Melsh.*

MELANOTUS.

M. corticinus *Say.*
M. macer *Lec.*
M. decumanus *Er.*
M. fissilis *Say.*
M. communis *Gyll.*
M. exuberans *Lec.*
M. parumpunctatus *Melsh.*
M. verberans *Lec.*
M. paganus *Chd.*
M. pertinax *Say.*
M. americanus *Hbst.*
M. insipiens *Say.*
M. gradatus *Lec.*
M. morosus *Cand.*
M. sagittarius *Lec.*

LIMONIUS.

L. auripilis *Say.*
L. aurifer *Lec.*
L. griseus *Beauv.*
L. interstitialis *Melsh.*
L. confusus *Lec.*
L. quercinus *Say.*
L. maculicollis *Mots.*
L. agonus *Say.*
L. ornatipennis *Lec.*

CAMPYLUS.

C. denticornis *Kby.*

ATHOUS.

A. brightwelli *Kby.*
A. acanthus *Say.*
A. scapularis *Say.*
A. posticus *Melsh.*
A. rufifrons *Rand.*

LEPTOSCHEMA.

L. bicolor *Lec.*

BLADUS.

B. quadricallis *Rand.*

NOTHODES.

N. dubitans *Lec.*

SERICOSOMUS.

S. silaceus *Say.*
S. flavipennis *Mots.*

CORYMBITES.

C. vernalis *Hentz.*
C. cylindriformis *Hbst.*
C. divaricatus *Lec.*
C. pyrrhos *Hbst.*
C. æthiops *Hbst.*
C. hamatus *Say.*
C. splendens *Ziegl.*
C. inflatus *Say.*

C. bivittatus *Melsh.*
C. tarsalis *Melsh.*
C. copei *Horn.*
C. sulcicollis *Say.*
C. planatus *Lec.*
C. crassus *Lec.*
C. rotundicollis *Say.*

Some of these are very rare, as *C. copei.* I have only seen two specimens. *C. vernalis* lives in the clay clinging to the roots of trees that have been uprooted by storms. It appears in March and April. March 23, 1902, I took what I think was its larvæ, by digging in the clay-covered roots of an upturned beech tree. Mrs. Braun found *C. hamatus* on the foliage of honey locust June 1, 1902.

ASAPHES.

A. indistinctus *Lec.*
A. decoloratus *Say.*
A. planatus *Lec.*
A. memnonius *Hbst.*
A. bilobatus *Say.*

MELANACTES.

M. piceus *De G.*
M. puncticollis *Lec.*

PEROTHOPS.

P. mucida *Gyll.*

CEROPHYTUM.

C. pulsator *Hald.*

This last is one of the rarest known Elaters, as well as the most abberrant. Its pectinate antennæ are very curious. But one specimen has been taken here, and that was beaten from foliage, into an umbrella. I have in addition to the above many Elaters without names, some of them very fine ones.

THROSCIDÆ.

DRAPETES.

D. geminatus *Say.*
D. quadripustulatus *Bonv.*

THROSCUS.

T. punctatus *Bonv.*
T. constrictor *Say.*
T. chevrolati *Bonv.*

The monograph of the THROSCIDÆ by Bonvouloir, 1859, is inaccessible to most students. See Horn's synopsis of N. A species. Trans. Am. Ent. Soc., 1885, vol. XII, pp. 198-208.

BUPRESTIDÆ.

"Metallic Shiners."

This family is not very abundant here. They are most beautiful metallic insects. Some of the tropical species are really magnifi-

cent. Many of the species are very destructive to trees, etc. *Chrysobothris* has killed some of our pine trees outright, and did considerable damage to fruit trees. I collect them on the trunks of dead trees and beat them from foliage into an umbrella. *Buprestis rufipes* is our most beautiful species, I have found its larvæ boring in beech and maple. During June specimens may be found sunning themselves on the trunks of dead beech and other trees. Approach them stealthily or they will drop into the weeds and be lost. From a single dead beech in Avondale over a hundred *rufipes* emerged or perished in the attempt. June to September.

CHALCOPHORA.

C. campestris *Say.*

Abundant; cuts its way out of beech and maple in April, May and June.

DICERCA.

D. divaricata *Say.*
D. obscura *Fab.*

PŒCILONOTA.

P. cyanipes *Say.*

BUPRESTIS.

B. rufipes *Oliv.*
B. fasciata *Fab.*
B. striata *Fab.*

The last two have been taken about lumber yards where pine timber was being sawed and were perhaps introduced into the locality.

CINYRA.

C. gracilipes *Melsh.*

MELANOPHILA.

M. longipes *Say.*

ANTHAXIA.

A. viridifrons *Say.*
A. viridicornis *Say.*
A. cyanella *Gory.*
A. quercata *Fab.*

CHRYSOBOTHRIS.

C. femorata *Oliv.*
C. floricola *Gory.*
C. pusilla *Lap.*
C. sexsignata *Say.*
C. azurea *Lec.*
C. scitula *Gory.*

ACTENODES.

A. acornis *Say.*

A large unidentified species, that is perhaps new.

ACMÆODERA.

A. ornata *Fab.*

A. pulchella *Hbst.*

A. culta *Web.*

PTOSIMA.

P. gibbicollis *Say.*

AGRILUS.

A. difficilis *Gory.*

A. ruficollis *Fab.*

A. otiosus *Say.*

A. crinicornis *Horn.*

A. arcuatus *Say.*

A. bilineatus *Web.*

A. granulatus *Say.*

A. acutipennis *Mann.*

A. politus *Say.*

A. fallax *Say.*

A. obsoletoguttatus *Gory.*

A. subcinctus *Gory.*

A. lecontei *Saund.*

A. addendus *Cr.*

A. egenus *Gory.*

A. pusillus*Say.*

TAPHROCERUS.

T. gracilis *Say.*

BRACHYS.

B. ovata *Web.*

B. ærosa *Melsh.*•

B. æruginosa *Gory.*

PACHYSCELUS.

P. purpureus *Say.*

P. lævigatus *Say.*

I have taken *Agrilus bilineatus* boring out of a solid beech tree. *A. ruficollis* bores in the stems of blackberry and raspberry. *A. lecontei* I find abundantly on honey locust. The others can be beaten from foliage into an umbrella. *Pachyscelus purpureus* I have taken eating holes in the leaves of wild geranium (*Geranium maculatum.*)

LAMPYRIDÆ.

"Fire Flies."

Soft bodied insects, many of which do not resemble beetles very closely. They rest during the day, but in the evening become active and fly about. The luminous species giving off their brilliant light. The life history of even many of the common species is unknown. Dr. Le Conte published a synopsis of N. A. species in Trans., 1881, vol. IX, pp. 15-72. Since then, Dr. Horn has published a paper on *Zaripus*. Trans., 1885, vol. XII, p. 148. Our species are:

LYCOSTOMUS.

L. lateralis *Melsh.*

CALOPTERON.

C. terminale *Say.*

C. reticulatum *Fab.*

LOPHEROS.

L. fraternus *Rand.*

EROS.

E. thoracicus *Rand.*
E. mundus *Say.*
E. aurora *Hbst.*
E. sculptilis *Say.*
E. humeralis *Fab.*

E. aurora is a beautiful red species quite rare here.

PLATEROS.

P. modestus *Say.*
P. canaliculatus *Say.*
P. floralis *Melsh.*

CALOCHROMUS.

C. perfacetus *Say.*

POLYCLASIS.

P. bifaria *Say.*

Superficially this species resembles the next, but it is quite different. I find them resting on trunks of trees in shady woods.

LUCIDOTA.

L. atra *Fab.*

ELLYCHNIA.

E. corrusca *Linn.*

PYROPYGA.

P. nigricans *Say.*
P. decipiens *Harr.*

PYRACTOMENA.

P. angulata *Say.*
P. lucifera *Melsh.*
P. pyralis *Linn.*
P. marginellus *Lec.*
P. scintillans *Say.*

PHOTURIS.

P. pennsylvanica *De G.*
P. frontalis *Lec.*

PHENGODES.

P. plumosa *Oliv.*

Very rare, only one male taken.

OMETHES.

O. marginatus *Lec.*

CHAULIOGNATHUS.

C. pennsylvanica *De G.*
C. marginata *Fab.*

PODABRUS.

P. tricostatus *Say.*
P. rugosulus *Lec.*
P. basilaris *Say.*
P. tomentosus *Say.*
P. protensus *Lec.*

SILIS.

S. percomis *Say.*

TELEPHORUS.

T. dentiger *Lec.*
T. excavatus *Lec.*
T. fraxini *Say.*
T. carolinus *Fab.*
T. lineola *Fab.*
T. rectus *Melsh.*
T. flavipes *Lec.*
T. scitulus *Say.*
T. pusillus *Lec.*
T. bilineatus *Say.*

DITEMNUS.

D. bidentatus *Say.*

TRYPHERUS.

T. latipennis *Germ.*

MALTHINUS.

M. flavicollis *Lec.*

MALTHODES.

M. exilis *Mels.*

These insects make very unsatisfactory looking specimens at best. Some methods of preparation are much better than others. Collect them dry, pin with good black pins, hold the head thorax and elytra in position until dry, and dry quickly. All of the smaller species should be mounted on paper triangles. A little alcoholic sol. of carbolic acid or corrosive sublimate injected into the soft abdominal parts is good.

MALACHIDÆ.

Small, rather soft bodied beetles that occur on vegetation. But little is known of their life history. Synopsis by Horn. Trans., 1872, vol. III, p. 79.

COLLOPS.

C. quadrimaculatus *Fab.*

ANTHOCOMUS.

A. erichsoni *Lec.*

PSEUDEBÆUS.

P. bicolor *Lec.*

ATTALUS.

A. morulus *Lec.*
A. humeralis *Lec.*
A. scincetus *Say.*

MELYRIS.

M. cribratus *Lec.*

CLERIDÆ.

The clerids are an enterprising and interesting family. I find most of the species about dead timber. A few occur on foliage. Synopsis by Le Conte. Ann. Lyc., 1849, vol. v, p. 9.

ELASMOCERUS.

E. terminatus *Say.*

TILLUS.

T. collaris *Spin.*

Only one of this species has been taken here.

CYMATODERA.

C. brunnea *Melsh.*
C. undulata *Say.*
C. bicolor *Say.*

PRIOCERA.

P. castanea *Newm.*

A rare species, taken under bark.

TRICHODES.

T. quadrimaculatus *Say.*
T. ichneumoneus *Fab.*
T. analis *Lec.*
T. thoracicus *Oliv.*
T. rosmarus *Say.*

THANEROCLERUS.

T. sanguineus *Say.*

HYDNOCERA.

H. unifasciata *Say.*
H. pedalis *Lec.*
H. subænea *Spin.*
H. verticalis *Say.*
H. humeralis *Say.*
H. tabida *Lec.*
H. pallipennis *Say.*
H. longicollis *Ziegl.*

PHYLLOBÆNUS.

P. dislocatus *Say.*

ICHNEA.

I. laticornis *Say.*

CHARIESSA.

C. pilosa *Forst.*

CREGYA.

C. oculata *Say.*
C. mixta *Lec.*

I have beaten a number of *Cregya* from osage orange hedges.

ORTHOPLEURA.

O. damicornis *Fab.*

NECROBIA.

N. rufipes *Fab.*
N. ruficollis *Fab.*
N. violaceus *Linn.*

I have taken *Necrobia* on an old decaying animal skin.

PTINIDÆ.

PTINUS.

P. fur *Linn.*
P. brunneus *Duft.*
P. quadrimaculatus *Melsh.*

EUCRADA.

E. humeralis *Melsh.*

Abundant on trunks of dead beech.

ERNOBIUS.

E. mollis *Linn.*

OLIGOMERUS.

O. sericans *Melsh.*
O. alternans *Lec.*

SITODREPA.

S. panicea *Linn.*

Found abundantly in drugs, etc.

HADROBREGMUS.

H. carinatus *Say.*
H. linearis *Lec.*

TRICHODESMA.

T. gibbosum *Say.*

ANOBIUM.

A. notatum *Say.*

TRYPOPITYS.

T. sericeus. *Say.*

PETALIUM.

P. bistriatum *Say.*

EUPACTUS.

E. nitidus *Lec.*

XYLETINUS.

X. peltatus *Harr.*
X. fucatus *Lec.*

HEMIPTYCHUS.

H. punctatus *Lec.*
H. gravis *Lec.*
H. borealis *Lec.*
H. ventralis *Lec.*
H. castaneus *Ham.*

DORCATOMA.

D. setulosum *Lec.*

CÆNOCARA.

C. oculata *Say.*

PTILINUS.

P. ruficornis *Say.* P. thoracicus *Rand.*

EUCERATOCERUS.

E. hornii *Lec.*

ENDECATOMUS.

E. reticulatus *Hbst.* E. rugosus *Rand.*

SINOXYLON.

S. basilare *Say.* S. bidentatum *Horn.*
S. sextuberculatum *Lec.*

BOSTRYCHUS.

B. bicornis *Web.* B. truncaticollis *Lec.*

DINODERUS.

D. punctatus *Say.*

LYCTUS.

L. striatus *Melsh.* L. opaculus *Lec.*

TROGOXYLON.

T. parallelopipedum *Walsh.*

I do not know of any complete paper on the PTINIDÆ. Le Conte and Horn have papers on several sub-families and genera in Proc. Acad., 1865, and Proc. Amer. Philos. Soc., 1878.

CUPESIDÆ.

CUPES.

C. concolor *West.*

LYMEXYLIDÆ.

HYLECŒTUS.

H. lugubris *Say.*

Very rare here, one only.

CIOIDÆ.

CIS.

C. creberrimus *Mellie.* C. fuscipes *Mellie.*
Many unnamed species.

ENNEARTHRON.

E. thoracicornis *Zieg.* E. vitulus *Mann.*

CERACIS.

C. sallei *Mellie.*

RHIPIDANDRUS.

R. paradoxus *Beauv.*

The minute cioids I have found abundantly on fungus.

SPHINDIDÆ.

SPHINDUS.

S. denticollis *Lec.*

This species occurs on fungus.

LUCANIDÆ.

"The Stag Beetles."

The larvæ of our species live in decaying wood. Chas. Fuchs in Bull. Brooklyn Ent. Soc., 1882, vol. v, p. 49, has a good synopsis of the family.

LUCANUS.

L. elaphus *Fab.* L. placidus *Say.*
L. dama *Fab.*

DORCUS.

D. parallelus *Say.*

PLATYCERUS.

P. quercus *Webr.*

PASSALUS.

P. cornutus *Fab.*

L. elaphus is rare here, the others common. While in the British Museum some years ago, a specialist, who was working on the LUCANIDÆ, expressed a wish for some fresh *Passalus*, for dissection. On my return to Ohio, I sent some in a small box by mail. About a month after my box, like the proverbial cat in the song, "came back," and stamped on it in red letters, were these words: "Suspected to be potato beetles, not allowed entry." The specimens had been examined very carefully, and after due deliberation, they decided that a dead *Passalus cornutus* was a living "potato beetle"!

SCARABÆIDÆ.

An extensive family of large insects. Some of the tropical forms are giants of the beetle tribe. *Dynastes*, sometimes called the "Rhinoceros beetle," is our largest coleopteron. Its larva is a huge grub of a dirty yellowish color, and feeds on decaying wood. One of the peculiarities of this species is the very powerful and strange odor given off by the adult beetle. In a Bulletin of U. S. Dept. of Agriculture, New Series No. 36, page 28, is a paper on the species, with most superb figures of the larva and pupa, natural size. In collecting the coprophagous *Scarabæidæ* by throwing the dung, in which many species live, into a bucket of water they will come out and can thus be cleaned, before being put into the bottle.

CANTHON.

C. depressipennis *Lec.*
C. vigilans *Lec.*
C. lævis *Drury.*
C. chalcites *Hald.*
C. viridis *Beauv.*

Some of these are skillful ball rollers. Specimens of *C. viridis* from Texas are bright green, ours are always rich bronze. They live in fungus. The species is rare here.

CHŒRIDIUM.

C. histeroides *Webr.*

COPRIS.

C. minutus *Drury.*
C. anaglypticus *Say.*
C. carolina *Linn.*

PHANÆUS.

P. carnifex *Linn.*

ONTHOPHAGUS.

O. hecate *Panz.*
O. janus *Panz.*
O. orpheus *Panz.*
O. striatulus *Beauv.*
O. subæneus *Beauv.*
O. pennsylvanicus *Harold.*

ÆGIALIA.

A. conferta *Horn.*

ATÆNIUS.

A. gracilis *Melsh.*
A. stercorator *Fab.*
A. abditus *Hald.*
A. rugiceps *n. sp.*

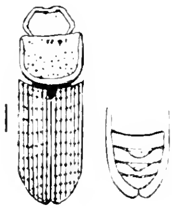
A species of *Ataenius* which I have taken here I think new and propose for it the name *A. rugiceps*, and describe it as follows:

Color, brown. The thorax darker and more shining than elytra. Entire front of head rugose; posterior part with a shallow punctured transverse groove. Clypeus emarginate in front. Thorax with sparse, scattered, very coarse punctures and a shal-

Ataenius rugiceps, **n. sp.**

low coarsely punctured groove, extending from base to middle. Front and hind thoracic angles prominent, sides arcuate and with a narrow margin extending across base and along sides to front angles. Elytra slightly narrower than thorax, sides straight, tips conjointly rounded. Striæ deep, impunctured, with sides of striæ feebly crenate. Abdomen with very minute punctures. Segments very prominent and rounded, sutures between them crenate. Mesosternum carinate between coxæ. Length 3-5 mm. One specimen. Cincinnati, O.

PLEUROPHORUS.



Pleurophorus ventralis **Horn.**

I took specimens of this species here in 1880, and sent them to Dr. Horn, who named it "*Ataenius*, n. sp." In Monograph of the *Aphodiini*, Trans. 1887, page 92, he describes it under the above name. I have what I think to be male and female of this remarkable species.

DIALYTES.

D. striatulus *Say.*

APHODIUS.

A. fimetarius *Linn.*
A. crassulus *Horn.*
A. ruricola *Melsh.*
A. granarius *Linn.*
A. serval *Say.*
A. inquinatus *Hbst.*
A. rubeolus *Beauv.*
A. stercorosus *Melsh.*
A. lentus *Horn.*
A. terminalis *Say.*
A. bicolor *Say.*
A. femoralis *Say.*
A. oblongus *Say.*

BOLBOCERUS.

B. tumefactus *Beauv.*
B. lazarus *Fabr.*

ODONTÆUS.

O. filicornis *Say.*
O. cornigerus *Mels.*

GEOTRUPES.

G. splendidus *Fabr.*
G. semiopacus *Jeckel.*
G. blackburnii *Fabr.*
G. " var. jecklii *Horn.*

Splendidus I have only taken in fungus, the others in excrement.

CLŒOTUS.

C. aphodiodes *Ill.*
C. globosus *Say.*

NICAGUS.

N. obscurus *Lec.*

TROX.

T. scutellaris *Say.*
T. monachus *Hbst.*
T. asper *Lec.*
T. suberosus *Fabr.*
T. punctatus *Germ.*
T. tuberculatus *De G.*
T. capillaris *Say.*
T. unistriatus *Beauv.*
T. foveicollis *Harold.*
T. terrestris *Say.*
T. æqualis *Say.*
T. scaber *Linn.*

Trox are abundant on dead animal remains. I have taken *capillaris, unistriatus* and *foveicollis* on an old hide of Virginia deer.

HOPLIA.

H. debilis *Lec.*
H. modesta *Hald.*

DICHELONYCHA.

D. bivittata *Lec.*
D. testacea *Kby.*
D. fuscula *Lec.*

SERICA.

S. vespertina *Gyll.*
S. iricolor *Say.*
S. sericea *Ill.*

MACRODACTYLUS.

M. subspinosus *Fab.*
M. angustatus *Beauv.*

DIPLOTAXIS.

D. harperi *Blanch.*
D. frondicola *Say.*

LACHNOSTERNA.

L. ephelida *Say.*
L. gibbosa *Burm.*
L. fusca *Froh.*
L. " var. arcuata *Smith.*
L. " var. brevicollis *Burm.*
L. fraterna *Harr.*
L. rugosa *Mels.*
L. hirticula *Knoch.*
L. comans *Burm.*
L. villifrons *Lec.*
L. ilicis *Knoch.*
L. crenulata *Froh.*
L. quercus *Knoch.*
L. inversa *Horn.*
L. tristis *Fab.*
L. hornii *Smith.*
L. albina *Burm.*

ANOMALA.

A. binotata *Gyll.*
A. minuta *Burm.*
A. undulata *Melsh.*
A. lucicola *Fabr.*
A. marginata *Fab.*

STRIGODERMA.

S. arboricola *Fab.*

PELIDNOTA.

P. punctata *Linn.*

COTALPA.

C. lanigera *Linn.*

CYCLOCEPHALA.

C. villosa *Burm.*

CHALEPUS.

C. trachypygus *Burm.*

LIGYRUS.

L. ruginasus *Lec.*
L. relictus *Say.*
L. pyriformis *Lec.*
L. tridentatus *Say.*

XYLORYCTES.

X. satyrus *Fab.*

DYNASTES.

D. tityus *Linn.*

PHILEURUS.

P. valgus *Fabr.*

ALLORHINA.

A. nitida *Linn.*

EUPHORIA.

E. sepulchralis *Fab.* E. inda *Linn.*
E. fulgida *Fab.*

CREMASTOCHILUS.

C. knochii *Lec.* C. variolosus *Kby.*

OSMODERMA.

O. eremicola *Knoch.* O. scabra *Beauv.*

GNORIMUS.

G. maculosus *Knoch.*

TRICHIUS.

T. piger *Fab.* T. bibens *Fab.*
T. affinis *Gory.*

VALGUS.

V. canaliculatus *Fab.* V. squamiger *Beauv.*

There is no complete monograph of the family SCARABÆIDÆ. Horn and Le Conte have excellent papers on many of the genera. These papers, which number 38 or more, have been published in Trans. Amer. Ent. Soc. from 1847 to 1880, but most of them from 1870 to 1880. In 1887 Dr. Horn revised *Lachnosterna* Trans. XIV, p. 209-296. Mr. F. Blanchard has a synopsis of *Canthon* in Trans. 1885, v. XII, p. 63. Mr. Blanchard also has a synopsis of *Geotrupes* in Psyche, 1888, v. V, p. 103. The latest paper on any N. A. Scarabæid genus is one by Mr. H. C. Fall on *Dichelonycha*, Trans. Aug., 1901, vol. XXVII, p. 277, and brings the subject down to date. The species of some of the genera are quite troublesome to separate. This is noticeably the case with *Lachnosterna*, *Diplotaxis*, etc. *Scarabæidæ* are, many of them abundant, some of the species alarmingly so. The larvæ of *Lachnosterna*, do great damage. The adults fly in swarms around electric lights. *L. hornii* is rare. I have taken it at light. *L. albina* is another rare species that I have found only by beating a certain haw tree (May 24) that stood in a thick woods. And though there were many other similar trees around, none of them produced any albina. *L. fusca* is our most abundant species. It is the larvæ of *Lachnosterna* that does such damage to grass lands, and lawns, by eating the roots of the grass. Large patches are killed in this way and the grass can be rolled up like a carpet, leaving the ground stripped bare. They are very difficult to combat as the larvæ are out of sight in the ground and can not easily be reached. The larvæ or "grub" of *Lachnosterna* are characteristic scarabæan larvæ and are figured in many works, such as Lugger's 5th report Entomologist of Minn., Packard

Guide to the Study of Insects, etc. The largest beetle occurring here belongs to this family. It is called *Dynastes tityus.* A fine male was taken on Eastern avenue, this city, July 1, 1900.

SPONDYLIDÆ.

PARANDRA.

P. brunnea *Fab.* P. polita *Say.*

P. brunnea is common, occurring late in summer and in fall, *polita* is very rare. I chopped three out of the heart of a large dead beech tree, 1878, August.

CERAMBYCIDÆ.

The "long-horned beetles."

A family that is numerously represented by many fine species. Some of them are very destructive to trees. The species I have seen from here are

ORTHOSOMA.

O. brunneum *Forst.*

PRIONUS.

P. laticollis *Drury.*

SPHENOSTETHUS.

S. taslei *Bates.*

ASEMUM.

A. mœstum *Hald.*

SMODICUM.

S. cucujiforme *Say.*

PHYSOCNEMUM.

P. brevilineum *Say.*

RHOPALOPUS.

R. sanguinicollis *Horn.*

HYLOTRUPES.

H. ligneus *Fab.*

PHYMATODES.

P. variabilis *Fab.* P. varius *Fab.*
P. amœnus *Say.*

CALLIDIUM.

C. antennatum *Newm.* C. ianthinum *Lec.*

DRYOBIUS.

D. sexfasciatus *Say.*

This is one of our most beautiful and graceful species. In former years it was abundant, but is now rare. Its larvæ bore in beech and maple. I have trapped them by nailing slabs of loose bark on the dead tree trunks, and visiting them every few days. Holding an inverted umbrella under the slab, to catch the beetles, when the bark was disturbed as they would drop to the ground. June and July.

CHION.

C. cinctus *Drury.*

C. cinctus var. garganicus *Fab.*

EBURIA.

E. quadrigeminata *Say.*

ROMALEUM.

R. atomarium *Drury.*

ELAPHIDION.

E. irroratum *Fab.*
E. mucronatum *Fab.*
E. incertum *Hald.*
E. villosum *Fab.*
E. parallelum *Newm.*
E. unicolor *Rand.*

TYLONOTUS.

T. bimaculatus *Hald.*

HETERACHTHES.

H. quadrimaculatus *Newm.*

PHYTON.

P. pallidum *Say.*

Beaten from dead osage orange. June.

OBRIUM.

O. rubrum *Newm.*

O. rubidum *Lec.*

Of the latter only one specimen.

MOLORCHUS.

M. bimaculatus *Say.*

CALLIMOXYS.

C. sanguinicollis *Oliv.*

RHOPALOPHORA.

R. rugicollis *Lec.*

PURPURICENUS.

P. humeralis *Fab.*

P. var. axillaris *Hald.*

BATYLE.

B. suturalis *Say.*

STENOSPHENUS.

S. notatus *Oliv.*

CYLLENE.

C. picta *Drury.* C. robiniæ *Forst.*

Look for *C. picta* on honey locust in June and July, and *C. robiniae* on golden rod in September.

PLAGIONOTUS.

P. speciosus *Say.*

ARHOPALUS.

A. fulminans *Fabr.*

XYLOTRECHUS.

X. colonus *Fab.* X. convergens *Lec.*
X. nitidus *Horn.*

X. nitidus is very rare here, three only.

NEOCLYTUS.

N. scutellaris *Oliv.* N. erythrocephalus *Fab.*

On a diseased tulip tree near my house *N. erythrocephalus* was ovipositing, Aug. 8, 1892.

CLYTANTHUS.

C. ruricola *Oliv.* C. albofasciatus *Lap.*

I beat the latter sp. from wild grape.

CYRTOPHORUS.

C. verrucosus *Oliv.*

EUDERCES.

E. picipes *Fab.*

DISTENIA.

D. undata *Oliv.*

DESMOCERUS.

D. palliatus *Forst.*

This species appears here on alder when it is in blossom.

NECYDALIS.

N. melitus *Say.*

A curious species with short wing cases. June.

ENCYCLOPS.

E. cæruleus *Say.*

CENTRODERA.

C. sublineata *Lec.*

A very rare species. I have only taken one.

TOXOTUS.

T. schaumii *Lec.*
T. cinnamopterus *Rand.*
T. cylindricollis *Say.*

ACMÆOPS.

A. bivittata *Say.*

GAUROTES.

G. cyanipennis *Say.*

BELLAMIRA.

B. scalaris *Say.*

Have taken a var. of this species jet black.

STRANGALIA.

S. famelica *Newm.*
S. luteicornis *Fab.*
S. acuminata *Oliv.*
S. bicolor *Swed.*

TYPOCERUS.

T. velutinus *Oliv.*
T. lugubris *Say.*

LEPTURA.

L. emarginata *Fab.*
L. lineola *Say.*
L. chalybæa *Hald.*
L. americana *Hald.*
L. exigua *Newm.*
L. subargentata *Kby.*
L. zebra *Oliv.*
L. rubrica *Say.*
L. proxima *Say.*
L. vittata *Germ.*
L. pubera *Say.*
L. ruficollis *Lec.*
L. sphæricollis *Say.*
L. vibex *Newm.*
L. aurata *Horn.*
L. mutabilis *Newm.*

L. emarginata. This fine large species emerges from dead beech timber in June; the holes are perfectly round and some of them one-half an inch in diameter. Many come from a single tree, yet it is very difficult to get specimens. I have only taken two, and Miss Braun two.

CYRTINUS.

C. pygmæus *Hald.*

This is the smallest of the family.

PSENOCERUS.

P. supernotatus *Say.*

MONOHAMMUS.

M. titillator *Fab.*
M. confusor *Kby.*
M. maculosus *Hald.*

DORCASCHEMA.

D. wildii *Uhler*.
D. nigrum *Say*.
D. alternatum *Say*.

The first two species occur on osage orange and mulberry. By beating the limbs into an inverted umbrella they can be secured, but *wildii* clings very tightly and the limbs must be struck very hard to disloge them. *D. nigrum* I find on hickory.

HETŒMIS.

H. cinerea *Oliv*.

GOES.

G. pulchra *Hald*.
G. oculata *Lec*.
G. debilis *Lec*.

ACANTHODERES.

A. quadrigibbus *Say*.
A. decipiens *Hald*.

LEPTOSTYLUS.

L. aculiferus *Say*.
L. commixtus *Hald*.
L. parvus *Lec*.
L. macula *Say*.

LIOPUS.

L. variegatus *Hald*.
L. alpha *Say*.
L. fascicularis *Harr*.
L. cinereus *Lec*.

L. variegatus breeds in honey locust.

DECTES.

D. spinosus *Say*.

LEPTURGES.

L. symmetricus *Hald*.
L. querci *Fitch*.
L. angulatus *Lec*.
L. facetus *Say*.
L. signatus *Lec*.
L. regularis *Lec*.

The latter is rare. I have beaten it from wild grape. The others are common and occur on honey locust.

HYPERPLATYS.

H. aspersus *Say*.
H. maculatus *Hald*.

UROGRAPHIS.

U. triangulifer *Hald*.
U. fasciatus *De G*.

The former occurs on honey locust, the latter on beech.

ACANTHOCINUS.

A. obsoletus *Oliv*.

ECYRUS.

E. dasycerus *Say*.
E. exiguus *Lec*.

EUPOGONIUS.

E. tomentosus *Hald.*
E. vestitus *Say.*
E. submarginatus *Lec.*

HIPPOPSIS.

H. lemniscata *Fab.*

SAPERDA.

S. calcarata *Say.*
S. vestita *Say.*
S. discoidea *Fab.*
S. tridentata *Oliv.*
S. lateralis *Fab.*
S. puncticollis *Say.*
S. concolor *Lec.*

S. calcarata depredates on poplars, bores holes into the Carolina poplars, causing them to break by the force of the wind. *L. tridentata* during the last four or five years has done incalculable damage in destroying the fine "white elms" (*Ulmus americana*) around this city. As *S. tridentata* has always been an abundant species here, I can not understand why it should suddenly become so destructive. Might it be due to the great destruction of woodpeckers that has been carried on here for years? I have often observed the red-headed woodpeckers (and other species) cutting out these larvæ from the trunks of the trees. *S. lateralis* occurs on hickory, *puncticollis* on Rhus.

MECAS.

M. inornata *Say.*

OBEREA.

O. tripunctata *Fab.*
O. basalis *Lec.*
O. schaumii *Lec.*
O. oculata *Hald.*
O. mandarina *Fab.*
O. ruficollis *Fab.*

TETROPS.

T. jucunda *Lec.*

TETRAOPES.

T. canteriator *Drap.*
T. tetraophthalmus *Forst.*

This last is the very common "milk weed" beetle. The former is quite rare here. The best papers on the "Longicorns," is synopsis of *Cerambycidae* by Chas. W. Leng, vols. I, II, III, IV, Entomologica Americana and Bull. Brooklyn Ent. Soc., vol. VII. This work, which includes *Leptura*, was supplemented and completed in 1896 by Mr. Leng and Dr. Hamilton, Trans. XXIII, p. 101. The Le Conte and Horn papers, in which were originally given many of these synoptic tables, are now out of print and unobtainable. The "Longicorns" have always been great favorites with collectors in all parts of the world. Some of them are very beautiful in form as well as color.

CHRYSOMELIDÆ.

"Leaf Eaters."

The numerous species of this family are mostly small insects, many of them of brilliant colors and pretty ornamentation. They can be collected in great numbers with a sweeping net, and also by using an inverted umbrella. Holding it under the vegetation, which is then beaten with a stick. The literature is scattered. Crotch, Le Conte and Horn have published many papers (about 60) in proceedings, Academy Natural Sciences and Trans. Amer-Ent. Soc., of Philadelphia, from 1851 to 1880. Since then Dr. Horn has published several papers on various genera in Trans. "Studies in Chrysomelidæ," vol. XIX, p. 1; *Eumolpini*, 1892, vol. XIX, p. 195; *Galerucini*, 1893, vol. XX, p. 59; *Halticini*, 1889, vol. XVI, p. 163. Mr. Leng revised the *Donacia* Trans., 1891, XVIII, p. 159. As many species of this family play a very important part in agriculture; they have been well studied by the Economic Entomologists, and their life histories worked out, with figures of many of the species and their larvæ. This work has been published in "Insect Life," and the reports of the different state Entomologists. These reports can be obtained if applied for in time, by those interested. Our genera and species are as follows:

DONACIA.

D. æqualis *Say.*
D. rufa *Say*
D. metallica *Ahrens.*

Of the 27 N. A. species and varieties of *Donacia* given by Mr. Leng, I have only taken three. This is doubtless due to want of suitable environment, such as lakes with lily pads and other aquatic vegetation.

SYNETA.

S. ferruginea *Germ.*

LEMA.

L. collaris *Say.*
L. trilineata *Oliv.*

ANOMŒA.

A. laticlavia *Forst.*

COSCINOPTERA.

C. dominicana *Fab.*

BABIA.

B. quadriguttata *Oliv.*

SAXINIS.

S. omogera *Lac.*

CHLAMYS.

C. plicata *Fab.*

EXEMA.

E. gibber *Oliv.*

BASSAREUS.

B. formosus *Melsh.*
B. detritus *Oliv.*
B. mammifer *Newm.*
B. recurvus *Say.*
B. lativittus *Germ.*

CRYPTOCEPHALUS.

C. quadrimaculatus *Say.*
C. quadriguttulus *Suff.*
C. quadruplex *Newm.*
C. guttulatus *Oliv.*
C. venustus *Fab.*
C. venustus var. simplex *Hald.*
C. " var. cinctipennis *Rand.*
C. insertus *Hald.*
C. mutabilis *Melsh.*
C. badius *Suffr.*

PACHYBRACHYS.

P. viduatus *Fab.*
P. trinotatus *Mels.*
P. tridens *Melsh.*
P. luridus *Fab.*
P. atomarius *Melsh.*
P. hepaticus *Melsh.*
P. dilatatus *Suffr.*

MONACHUS.

M. ater *Hald.*
M. saponatus *Fab.*
M. seminulum *Suffr.*

DIACHUS.

D. auratus *Fab.*
D. pallidicornis *Suffr.*
D. chlorizans *Suffr.*

XANTHONIA.

X. 10-notata *Say.*
X. villosula *Melsh.*

FIDIA.

F. murina *Cr.*
F. longipes *Melsh.*

GLYPTOSCELIS.

G. barbatus *Say.*

MYOCHROUS.

M. denticollis *Say.*

CHRYSOCHUS.

C. auratus *Fab.*

TYMNES.

T. bicolor *Fab.*

TYPOPHORUS.

T. viridicyaneus *Cr.*
T. canella *Fab.*

Dr. Horn suppresses all the other species given in the check lists. Our *viridicyaneus* are green, those from Texas bright blue.

Canella varies very much, being of all shades of color from light all over, to jet black, which is the form called *aterrima*.

GRAPHOPS.

G. marcassita *Cr.* G. nebulosa *Lec.*

COLASPIS.

C. brunnea *Fab.*

RHABDOPTERUS.

R. picipes *Oliv.*

This is the form given in the check lists as *Colaspis praetexta*. See Horn's paper on *Eumolpini* before referred to.

NODONOTA.

N. tristis *Oliv.* N. convexa *Say.*
N. clypealis *Horn.* N. puncticollis *Lec.*

DORYPHORA.

D. clivicollis *Kby.* D. juncta *Germ.*
D. decemlineata *Say.*

The larvæ of *D. juncta* are different looking from *decemlineata* and only found on *Physalis*. June.

CHRYSOMELA.

C. suturalis *Fab.* C. scalaris *Lec.*
C. similis *Rog.* C. multipunctata *Say.*
C. præcelsis *Rog.* C. " var. bigsbyana *Kby.*
C. elegans *Oliv.* C. multiguttata *Stahl.*

GASTROIDEA.

G. polygoni *Linn.* G. cyanea *Melsh.*

LINA.

L. lapponica *Linn.* L. scripta *Fab.*

CEROTOMA.

C. trifurcata *Forst.*

PHYLLOBROTICA.

P. discoidea *Fab.*

PHYLLECHTHRUS.

P. gentilis *Lec.*

DIABROTICA.

D. duodecimpunctata *Oliv.* D. vittata *Fab.*
D. longicornis *Say.*

TRIRHABDA.

T. virgata *Lec.*

GALERUCELLA.

G. sexvittata *Lec.*
G. notulata *Fab.*
G. nymphææ *Linn.*
G. tuberculata *Say.*
G. decora *Say.*

GALERUCA.

G. externa *Say.*

BLEPHARIDA.

B. rhois *Forst.*

HYPOLAMPSIS.

H. pilosa *Ill.*

PHEDROMUS.

P. paradoxus *Melsh.*

ŒDIONYCHIS.

O. gibbitarsis *Say.*
O. vians *Ill.*
O. thoracica *Fab.*
O. petaurista *Fab.*
O. thyamoides *Cr.*
O. sexmaculata *Ill.*
O. limbalis *Melsh.*

DISONYCHA.

D. pennsylvanica *Ill.*
D. caroliniana *Fab.*
D. glabrata *Fab.*
D. abbreviata *Mels.*
D. discoidea *Fab.*
D. xanthomelæna *Dahl.*
D. mellicollis *Say.*
D. collata *Fab.*

SPHÆRODERMA.

S. opima *Lec.*

HALTICA.

H. chalybea *Ill.*
H. ignita *Ill.*
H. carinata *Germ.*
H. fuscoænea *Mels.*
H. burgesi *Cr.*

TRICHALTICA.

T. scrabricula *Cr.*

ORTHALTICA.

O. copalina *Fab.*

CREPIDODERA.

C. rufipes *Linn.*
C. helxines *Linn.*
C. atriventris *Melsh.*

EPITRIX.

E. fuscula *Cr.*
E. lobata *Cr.*
E. cucumeris *Harr.*
E. parvula *Fab.*

MANTURA.

M. floridana. *Cr.*

CHÆTOCNEMA.

C. protensa *Lec.*
C. denticulata *Illig.*
C. parcepunctata *Cr.*
C. confinis *Cr.*

SYSTENA.

S. hudsonias *Forst.*
S. senilis *Say.*

APHTHONA.

A. insolita *Mels.*

PHYLLOTRETA.

P. sinuata *Steph.*
P. vittata *Fab.*
P. bipustulata *Fab.*
P. picta *Say.*

LONGITARSUS.

L. turbatus *Horn.*
L. testaceus *Mels.*
L. solidaginis *Horn.*

GLYPTINA.

G. spuria *Lec.*

DIBOLIA.

D. borealis *Chev.*

PSYLLIODES.

P. convexior *Lec.*

MICRORHOPALA.

M. porcata *Melsh.*

ODONTOTA.

O. dorsalis *Thunb.*
O. rubra *Web.*
O. nervosa *Panz.*

OCTOTOMA.

O. plicatula *Fab.*

STENISPA.

S. metallica *Fab.*

CASSIDA.

C. bivittata *Say.*

COPTOCYCLA.

C. aurichalcea *Fab.*
C. guttata *Oliv.*
C. purpurata *Boh.*
C. clavata *Fab.*

CHELYMORPHA.

C. argus *Licht.*

Octotoma plicatula is a very curious species. I have found it abundantly on the "Trumpet flower" (*Tecoma radicans*).

Coptocycla is abundant on the "wild morning glory" (*Calystegia sepium*). It is of the most beautiful golden hue, when fresh,

but when touched, begins to fade, and after death loses all of its golden color. *Microrhopala* is very rare here.

BRUCHIDÆ.

"Pod Weevels."

Some of this family do considerable damage to beans, peas, etc. Dr. Horn has a fine synopsis of the family in Trans. American Ent. Soc., 1873, vol. IV, pp. 311-342.

SPERMOPHAGUS.

S. robiniae *Sch.*

BRUCHUS.

B. pisi *Linn.*
B. mimus *Say.*
B. discoideus *Say.*
B. bivulneratus *Horn.*
B. obsoletus *Say.*
B. hibisci *Oliv.*
B. musculus *Say.*

TENEBRIONIDÆ.

"Dark ground beetles."

Of this large and varied family we have comparatively few species. Their metropolis being the semi-desert and sandy regions of the West. Dr. Horn published a monog. of the family in Trans. Amer. Philos. Soc., 1870, new series, vol. XIV, pp. 253-404, a paper now hard to get. Since then the same author and Dr. Le Conte have published synoptic tables of a number of genera in Trans. Amer. Ent. Soc., scattered from 1866 to 1880. Maj. T. L. Casey has a number of synoptic tables in the Ann. N. Y. Acad., 1890-91. Some of these treat of genera to which our local species belong.

NYCTOBATES.

N. pennsylvanicus *De G.*
N. barbatus *Knoch.*

The first occurs in great numbers under the loose bark of trees, the other is rare here, and differs in being smaller with much coarser punctures.

HAPLANDRUS.

H. femoratus *Fab.*

SCOTOBATES.

S. calcaratus *Fab.*

XYLOPINUS.

X. saperdioides *Fab.*

TENEBRIO.

T. obscurus *Fab.*
T. molitor *Linn.*
T. castaneus *Knoch.*
T. tenebrioides *Beauv.*

ADELINA.

A. pallida *Say.*

OPATRINUS.

O. notus *Say.*

TRIBOLIUM.

T. ferrugineum *Fab.*
T. confusum *Duv.*

In package of buckwheat flour I found thousands of confusum and its larvæ, Sep.

DIŒDUS.

D. punctatus *Lec.*

ECHOCERUS.

E. maxillosus *Fab.*

ALPHITOBIUS.

A. diaperinus *Panz.*

THARSUS.

T. seditiosus *Lec.*

ULOMA.

U. impressa *Melsh.*
U. imberbis *Lec.*

EUTOCHIA.

E. picea *Melsh.*

ANÆDUS.

A. brunneus *Ziegl.*

PARATENETUS.

P. punctatus *Sol.*
P. fuscus *Lec.*

PRATÆUS.

P. fuscula *Lec.*

DIAPERIS.

D. hydni *Fab.*

HOPLOCEPHALA.

H. bicornis *Oliv.*

PLATYDEMA.

P. excavatum *Say.*
P. ruficornis *Sturm.*
P. flavipes *Fab.*
P. ellipticum *Fab.*
P. picilabrum *Melsh.*
P. subcostatum *Lap.*

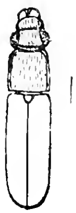
PHYLETHUS.

P. bifasciatus *Say.*

HYPOPHLŒUS.

H. thoracicus *Melsh.* H. parallelus *Melsh.*

H. thoracicus was emerging from dead beech October 3, 1900. I have taken here a *Hypophlœus* which is new, and for which I propose the name *Hypophlœus rugosus.* I took the species years ago and gave specimens to Drs. Horn and Le Conte, who then pronounced it new. I have not heard that it has been described. Its characters are as follows:



Hypophlœus rugosus n. sp.

Dark brown, subshining, linear. Thorax slightly longer than wide, squarely truncate in front and behind, sides arcuate, angles obtuse, coarsely punctured. Interstices forming longitudinal rugæ more evident in front and at sides. Elytra conjointly rounded at tip, obsoletely striate and densely punctate, punctures finer than those of thorax. Head evenly and finely puntured with a shallow constriction behind the eyes, which are very prominent. Antennæ (including four-jointed club), ten-jointed. Length, 3.8 mm. Eight specimens. Cincinnati, Ohio.

PENTAPHYLLUS.

P. pallidus *Lec.*

BOLITOTHERUS.

B. bifurcus *Fab.*

BOLETOPHAGUS.

B. corticola *Say.*

HELOPS.

H. micans *Fab.* H. cisteloides *Germ.*

MERACANTHA.

M. contracta *Beauv.*

STRONGYLIUM.

S. terminatum *Say*.
S. crenatum *Makl.*

Crenatum is a rare and beautiful species. I have beaten specimens from the dead branches of Haw tree, June 22, 1900, and June 26, 1901.

CISTELIDÆ.

Maj. Casey has published a synopsis of this family in annals of N. Y. Acad. Sciences, 1891, vol. VI, pp. 69-170.

ALLECULA.

A. nigrans *Melsh.*

HYMENORUS.

H. obscurus *Say*.
H. niger *Mels.*
H. rufipes *Lec.*
H. humeralis *Lec.*
H. difficilis *Casey*.

CISTELA.

C. brevis *Say*.
C. amœna *Say*.

ISOMIRA.

I. quadristriata *Coup.*
I. valida *Sz.*
I. ruficollis *Ham.*

MYCETOCHARA.

M. haldemani *Lec.*
M. fraterna *Say*.
M. foveata *Lec.*
M. gilvipes *Csy.*
M. megalops *Csy.*
M. tenuis *Lec.*
M. marginata *Lec.*
M. binotata *Say*.
M. gracilis *Lec.*
M. laticollis *Lec.*

This was once a very rich locality for *Mycetochara*. I found them in numbers on the trunks of dead trees. They are brittle insects, breaking easily when handled. To get them perfect, they should be picked up gently, not an easy thing to do, as they run so rapidly and are not easily caught. They feed on fungus. I have a species which I believe to be new and for which I propose the name:

Mycetochara horni **n. sp.**

Color testaceus, head and thorax darker. Legs paler. Anterior coxæ very large and approximate. Elytra slightly wider behind

from middle. Separately rounded at tips. Striae moderately deep, punctured and clothed with sparse, long, yellow, recumbent hairs. Thorax wider than long, narrower than elytra at humeri, broadly rounded in front, explanate at sides from apex to base, more broadly at hind angles, which are obtusely rounded. Base almost squarely truncate, disk with a broad shallow grove from base to apex. Punctures rather coarser than those of elytra. Head still more coarsely and deeply punctured. Eyes very large and prominent, as large or larger in proportion than those of *megalops* Casey, separated by the width of their narrowest diameter. Body below rather coarsely and sparsely punctured. A large species, as large or larger than the largest *binotata*. Length 7.8 mm. Cincinnati, Ohio. I have seen two specimens. In looking at it years ago Dr. Horn thought it new, and I have not seen any description of it, so I dedicate it to him.

CAPNOCHROA.

C. fuliginosa *Melsh.*

ANDROCHIRUS.

A. fuscipes *Melsh.* A. erythropus *Kby.*
A. femoralis *Oliv.*

LAGRIIDÆ.

ARTHROMACRA.

A. ænea *Say.*

STATIRA.

S. splendens *Melsh.* S. gagatina *Melsh.*

Dr. Horn has a synopsis of this family. Trans. 1888, vol. xv, p. 28. I find them by beating vegetation into an inverted umbrella. May and June.

MELANDRYIDÆ.

TETRATOMA.

T. truncorum *Lec.* T. tessellata *Melsh.*

PENTHE.

P. obliquata *Fab.* P. pimelia *Fab.*

P. obliquata differs from the other by having the scutellum covered with orange colored hairs.

SYNCHROA.

S. punctata *Newm.*

MALLODRYA.

M. subænea *Horn.*

I discovered this new genus here in 1887. Dr. Horn described

it in Trans. April, 1888, vol. xv., p. 42. I beat the specimens, which were then abundant, from the branches of dead "honey locust."

MELANDRYA.

M. striata *Say.*

SPILOTUS.

S. quadripustulosus *Mels.*

ENCHODES.

E. sericeus *Hald.*

MYSTAXUS.

M. simulator *Newm.*

HYPULUS.

H. lituratus *Say.*
H. concolor *Lec.*
H. vandoueri *Muls.*

SYMPHORA.

S. flavicollis *Hald.*
S. rugosa *Hald.*

EUSTROPHUS.

E. repandus *Horn.*
E. tomentosus *Say.*
E. bicolor *Say.*

HOLOSTROPHUS.

H. bifasciatus *Say.*

HALLOMENUS.

H. scapularis *Melsh.*

ORCHESIA.

O. castanea *Mels.*
O. gracilis *Muls.*

CANIFA.

C. plagiata *Melsh.*
C. pallipes *Melsh.*
C. pusilla *Hald.*

NOTHUS.

N. varians *Lec.*

LACCONOTUS.

L. punctatus *Lec.*

Dr. Horn has published synopses of *Hypulus, Eustrophus, Holostrophus* and *Orchesia* in Trans., 1888, vol. xv. He gave *Mycterus* and *Lacconotus* in same publication in 1879 (vol. 7). Le Conte published syn. of *Hallomenus* in Proc. Amer. Philos. Soc., 1878, vol. 17, p. 619.

PYTHIDÆ.

PYTHO.

P. americanus *Kby.*

Only this one species of this family has been taken here, and that years ago.

ŒDEMERIDÆ.

MICROTONUS.

M. sericans *Lec.*

NACERDES.

N. melanura *Linn.*

OXACIS.

O. cana *Lec.*

ASCLERA.

A. ruficollis *Say.*
A. puncticollis *Say.*

MORDELLIDÆ.

In this journal, October, '92, p. 123, I published a paper enumerating 53 species found here. Since then a few additions have been made. The locality is very rich in the family. The synopsis by John B. Smith (Trans. Amer. Ent. Soc., July, 1882) is the latest and best on the subject.

PENTARIA.

P. trifasciata *Mels.*

TOMOXIA.

T. bidentata *Say.*
T. hilaris *Say.*
T. linella *Lec.*

MORDELLA.

M. borealis *Lec.*
M. serval *Say.*
M. malæna *Germ.*
M. oculata *Say.*
M. scutellaris *Fab.*
M. triloba *Say.*
M. octopunctata *Fab.*
M. undulata *Mels.*
M. marginata *Melsh.*
M. discoidea *Mels.*
M. lunulata *Hel.*

GLIPODES.

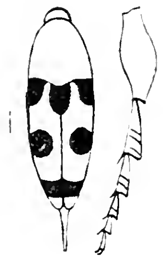
G. sericans *Mels.*

MORDELLISTENA.

M. bicinctella *Lec.*
M. varians *Lec.*
M. arida *Lec.*
M. gramica *Lec.*
M. lutea *Melsh.*
M. ustulata *Lec.*

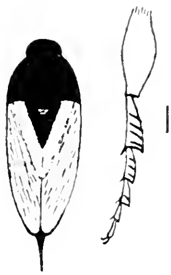
M. trifasciata *Say.*
M. lepidula *Say.*
M. limbalis *Melsh.*
M. biplagiata *Helm.*
M. vilis *Lec.*
M. vapida *Lec.*
M. decorella *Lec.*
M. bipustulata *Hel.*
M. picipennis *Smith.*
M. fulvicollis *Melsh.*
M. militaris *Lec.*
M. comata *Lec.*
M. aspersa *Mels.*
M. tosta *Lec.*
M. amica *Lec.*
M. picilabris *Hel.*
M. infima *Lec.*
M. semiusta *Say.*
M. nigricans *Mels.*
M. pustulata *Mels.*
M. convicta *Lec.*
M. splendens *Smith.*
M. morula *Lec.*
M. ambusta *Lec.*
M. singularis *Smith.*
M. unicolor *Lec.*
M. marginalis *Say.*
M. pubescens *Fab.*
M. bihamata *Mels.*
M. liturata *Mels.*
M. fuscata *Mels.*
M. suturella *Helm.*
M. attenuata *Say.*
M. discolor *Mels.*

Among the unidentified species I have taken here, two are so distinct that I describe them as new, and characterize them as follows:



Mordellistena sexnotata, n. sp.

Brownish yellow, sparsely covered with coarse hairs, which are finer and more sparse on head. Humeri each with a very dark brown spot. Another in middle of elytra, beginning at base surrounding scutellum and extending backward in triangular shape about one third the length. A large nearly round spot on each elytron at middle, but not attaining suture. And a sixth spot or band across the elytra at posterior fourth, not attaining the tip. A fain darker spot on disk of thorax. Tibia with three oblique black ridges, the one nearest the tip being shorter. First joint of tarsi with two, second with one. Legs all pale, length 3 mm. One specimen Ky. opp. Cin., O.



Mordellistena smithi, **n. sp.**

Piceus black. Anterior and middle legs testaceus. Elytra rufo piceous with lighter red splotches on humeri extending obliquely backward toward the suture. The amount of red varies, in some specimens being more extended. Pubescence coarse, yellow. Hind tibia with three, 1st tarsal joint with three, 2d with one, well defined ridges. Length, 3.5 mm. 14 specimens, Cincinnati, O. To my old friend, Prof. John B. Smith, of New Jersey, this species is dedicated. His excellent paper on the family (Trans., July, 1882, p. 73) was the inspiration that started me into a study of this interesting family. I have a number of *Mordellistena* that are perhaps also new, which I have reserved for future study.

ANTHICIDÆ.

EURYGENIUS.

E. wildii *Lec.*

STEREOPALPUS.

S. mellyi *Laf.*

CORPHYRA.

C. canaliculata *Lec.*
C. pulchra *Lec.*
C. terminalis *Say.*
C. labiata *Say.*
C. fulvipes *Newm.*
C. lugubris *Say.*

Corphyra labiata was an abundant species during May and June. Found on tall "horse weeds" (*Ambrosia trifida*) growing in river bottoms. Associated with them, but very much less abundant, was the form described as *C. pulchra* by Le Conte. This seems to be a mere variety of *C. labiata* having the legs pale. In a large series they average the same size. *C. lugubris* is an abundant species (May-June). *C. fulvipes*, seems to be a variety of *C. lugubris* having the legs pale. It is less abundant than *lugubris*. Of *C. terminalis Say*. Dr. Horn says, Trans., 1871, p.

282: "Yellow space at apex of elytra not impressed." In a large series of males, I start with the typical male form as defined above. Then one with the faintest trace of an impression, and so on, more and more defined, until one is reached with a well defined impression, close to the suture but not attaining apical angle. When Le Conte described *C. canaliculata*, Smith. Mis. Collections, pt. 1, p. 143, only a single one (type) was known. During 1880, I collected hundreds on the blossoms of "white thorn" and "buckeye," but all were females. They varied from the type in color as follows: Thorax rufous, elytra black, and legs black. The legs in the type were pale, thorax and elytra black, legs pale, and black all over. Surely if *C. pulchra* and *fulvipes* are good species, several could be made of *canaliculata*. Since 1880 I have secured several males. They have the apices of elytra broadly tipped with pale. Why the males should be so extremely rare, I do not know. At certain "haw" trees when in blossom, by holding my umbrella inverted under the branches and striking them a hard blow with a stick, *Corphyra* would shower down, hundreds to a tree, and yet the larvæ are to me absolutely unknown, nor have I the slightest idea where to look for them.

XYLOPHILUS.

X. basilis *Lec.*
X. nebulosus *Lec.*
X. fasciatus *Mels.*
X. piceus *Lec.*

MACRATRIA.

M. murina *Fab.*

NOTOXUS.

N. bicolor *Say.*
N. bifasciatus *Lec.*
N. monodon *Fabr.*
N. anchora *Hentz.*

TOMODERUS.

T. constrictus *Say.*

DILANDIUS.

D. myrmecops *Csy.*

I took this singular species from under a flat stone, Nov. 17.

ANTHICUS.

A. obscurus *Laf.*
A. sturmii *Laf.*
A. formicarius *Laf.*
A. cinctus *Say.*
A. floralis *Payk.*
A. cervinus *Laf.*
A. pubescens *Lec.*

The synopsis by Le Conte, Proc. Acad. Nat. Science of Phil., vol. 6, p. 9, is very old, being publishing in 1852, since then Dr. Horn has published good synopsis of *Corphyra* and *Notoxus* Trans., vol. x, 1883. Maj. Casey has paper on *Anthicidæ*, Col. notices in Annals of N. Y. Acad. Sciences, VIII, p. 624.

PYROCHROIDÆ.

PYROCHROA.

P. flabellata *Fab.* P. femoralis *Lec.*

DENDROIDES.

D. bicolor *Newm.* D. concolor *Newm.*

Le Conte published synopsis in 1855, Proc. Acad., vol. 7, p. 274.

MELOIDÆ.

"Blister Beetles."

This family is not very abundant here. Le Conte published synopsis in 1853, vol. 6, p. 328-350. *Macrobasis* and *Epicauta* were treated by Horn in 1873, Proc. Am. Philos. Soc., vol. 13.

MELOE.

M. impressus *Kby.*

TRICRANIA.

T. sanguinipennis *Say.*

March 22, 1896, I took 7 of this species crawling on "sorrel," *Rumex.*

ZONITIS.

Z. bilineata *Say.*

MACROBASIS.

M. unicolor *Kby.* M. immaculata *Say.*

EPICAUTA.

E. vittata *Fab.* E. pennsylvanica *De G.*

E. cinerea *Forst.*

POMPHOPŒA.

P. ænea *Say.*

April 27, 1891, I took a fine male and female of this species from the throat of a kingbird I had shot for preservation.

RHIPIPHORIDÆ.

PELECOTOMA.

P. flavipes *Melsh.*

But one specimen of this species in many years.

RHIPIPHORUS.

R. dimidiatus *Fab.* R. limbatus *Fab.*

R. cruentus *Germ.*

I find these three species in the fall on flowers.

MYODITES.

M. fasciatus *Say.*

Myodites are found on blossoms but they take flight so quickly when alarmed, that they are quite difficult to catch.

STYLOPIDÆ.

XENOS.

X. peckii *Kby.*

A very curious genus that is parasitic in the bodies of wasps. During 1900 and 1901 I captured a number of wasps that were infected with these very interesting little creatures. The figures given in Packard's Guide to the Study of Insects, p. 482-483, for *Stylops childreni* are exactly those of *Xenos peckii* as I have been able to identify the species. Our talented and lamented friend, H. G. Hubbard, has given a most interesting account of the rearing of *Xenos* from a colony of wasps in Fla. See Can. Entomologist, Oct., 1892, p. 259. I have one of these specimens and it only differs from mine in being of a pale color, mine being sooty black. I have hatched *Xenos* from the following wasps, viz.: *Ammophila urnaria, Polistes fuscatus, Prionyx atrata, Sphex ichneumonea, Odynerus molestus.*

I have pinned in my box with *Xenos* the following host wasps, viz.:

Poslistes 5, *Prionyx* 3, *Ammophila* 2, *Sphex* and *Odynerus* one each. And this is about the proportion in which I found they were infected. I confined the infected wasps in tumbler with false bottom of screen wire, first putting in bit of blotter to absorb moisture that might run down. I fed the wasps jelly and water, which they greedily ate, first convincing themselves that they could not escape. Stylopized individuals appeared during June, July, August, September and October. Most of the male *Xenos* were hatched in August. Several wasps died before the beetles hatched. From one of these I hatched the beetle after the wasp had been dead two days; from another dead wasp containing only female *Xenos*, a lot of the minute larvæ hatched and crawled out on the tips of the hairs of the wasp and died there. The activity of the male *Xenos*, so well described by Mr. Hubbard in the article above referred to, is simply astonishing, and it is no wonder that the creature wears itself out and dies in 20 or 30 minutes. If the wasp can catch the *Xenos* she makes short work of it. In trying to take out of tumbler a male *Xenos* I allowed it to escape and it darted away like a flash. The *Xenos* when hatched is jet, opaque black, the fan-like wings when fresh have a beautiful mother of pearl iridescent tinge. The body is very flexible and

they keep twisting and writhing it about. How union of the sexes is effected I have so far been unable to find out. Though if the end of the female that projects is the end that receives the male, then the operation would be considerably simplified.

The remaining families are called "Snout Beetles" and "Weevils." Most of them have the head prolonged into a snout or proboscis.

RHYNCHITIDÆ.

EUGNAMPTUS.

E. angustatus *Hbst.* E. collaris *Fab.*

RHYNCHITES.

R. hirtus *Fab.*

ATTELABIDÆ.

ATTELABUS.

A. bipustulatus *Fab.*

OTIORHYNCHIDÆ.

HORMORUS.

H. undulatus *Uhler.*

AMNESIA.

A. grisea *Horn.*

PANSCOPUS.

P. erinaceus *Say.*

PHYXELIS.

P. rigidus *Say.*

CERCOPEUS.

C. chrysorrhaeus *Say.*

TANYMECUS.

T. confertus *Gyll.*

PANDELETEJUS.

P. pilaris *Hast.*

BRACHYSTYLUS.

B. acutus *Say.*

APHRASTUS.

A. tæniatus *Say.*

CYPHOMIMUS.

C. dorsalis *Horn.*

ARACANTHUS.

A. pallidus *Say.*

SITONES.

S. flavescens *Marsh.*

CURCULIONIDÆ.

ITHYCERUS.

I. noveboracensis *Forst.*

APION.

A. cribricolle *Lec.*
A. porcatum *Boh.*

Many unidentified species.

The latest paper on *Apion* is by Mr. H. C. Fall, Trans., vol. 25, Oct., 1898, p. 105.

PHYTONOMUS.

P. punctatus *Fab.*
P. comptus *Say.*

LISTRONOTUS.

L. tuberosus *Lec.*
L. squamiger *Say.*
L. inæqualipennis *Boh.*
L. sulcirostris *Lec.*
L. latiusculus *Boh.*
L. caudatus *Say.*

Many unnamed species.

MACROPS.

M. spureus *Boh.*
M. solutus *Boh.*

Many unnamed species.

LIXUS.

L. punctinasus *Lec.*
L. terminalis *Lec.*
L. concavus *Say.*
L. amplexus *Casey.*

DORYTOMUS.

D. mucidus *Say.*
D. brevicollis *Lec.*

BARYTYCHIUS.

B. amœnus *Say.*

SMICRONYX.

S. ovipennis *Lec.*
S. flavicans *Lec.*
S. tychoides *Lec.*
S. vestitus *Lec.*
S. corniculatus *Fab.*

ONYCHYLIS.

O. nigrirostris *Boh.*

LISSORHOPTRUS.

L. simplex *Say.*

BAGOUS.

B. sellatus *Lec.*
B. magister *Lec.*
B. restrictus *Lec.*
B. mammillatus *Say.*

OTIDOCEPHALUS.

O. myrmex *Hbst.*
O. chevrolatii *Horn.*
O. lævicollis *Horn.*
O. perforatus *Horn.*

The last named is rare, the others common. *Perforatus* may be known from the others, by its brown color, the others are shining black; good anatomical characters, however, separate them. See Horn's Synopsis, Proc. Amer. Philos. Soc., 1873, vol. 13, p. 448.

MAGDALIS.

M. lecontei *Horn.*
M. barbita *Say.*
M. pandura *Say.*
M. armicollis *Say.*
M. pallida *Say.*

COCCOTORUS.

C. scutellaris *Lec.*

ANTHONOMUS.

A. quadrigibbus *Say.*
A. nebulosus *Lec.*
A. profundus *Lec.*
A. scutellatus *Gyll.*
A. signatus *Say.*
A. suturalis *Lec.*
A. corvulus *Lec.*
A. cratægi *Walsh.*
A. mixtus *Lec.*
A. validus *Dtz.*

ORCHESTES.

O. pallicornis *Say.*
O. canus *Horn.*
O. niger *Horn.*
O. ephippiatus *Say.*

ELLESCHUS.

E. ephippiatus *Say.*

PRIONOMERUS.

P. calceatus *Say.*

PIAZORHINUS.

P. scutellaris *Say.*

THYSANOCNEMIS.

T. fraxini *Lec.*
T. helvola *Lec.*

PLOCETES.

P. ulmi *Lec.*

GYMNETRON.

G. teter *Fab.*

LEMOSACCUS.

L. plagiatus *Fab.*

CONOTRACHELUS.

C. juglandis *Lec.*
C. albicinctus *Lec.*
C. nenuphar *Hbst.*
C. seniculus *Lec.*
C. affinis *Sch.*
C. elegans *Boh.*
C. cratægi *Melsh.*
C. adspersus *Lec.*
C. posticatus *Say.*
C. geminatus *Dej.*
C. cribricollis *Say.*
C. tuberosus *Lec.*
C. anaglypticus *Say.*
C. erinaceus *Lec.*

RYSSEMATUS.

R. palmacollis *Say.*
R. æqualis *Horn.*
R. annectens *Casey.*

The last species I found eating out the heads of the "swamp mild weed" (*Asclepias incarnata*) growing on the border of ponds. May 24. It was abundant.

ZAGLYPTUS.

Z. sulcatus *Lec.*
Z. striatus *Lec.*

Sulcatus is abundant, *striatus* is rare. It has been suggested to me that they were sexes of each other, but I am convinced they are distinct, as I have found both species paired.

MICROHYUS.

M. setiger *Lec.*

ACAMPTUS.

A. rigidus *Lec.*
A. echinus *Lec.*

ACALLES.

A. carinatus *Lec.*
A. sordidus *Lec.*
A. clavatus *Say.*

CANISTES.

C. schusteri *Casey.*

TYLODERMA.

T. foveolatum *Say.*
T. nigrum *Casey.*
T. æreum *Say.*
T. fragariæ *Riley.*
T. variegatum *Horn.*

PSOMUS.

P. politus *Casey.*

PHYRDENUS.

P. undatus *Lec.*

CRYPTORHYNCHUS.

C. parochus *Hbst.*
C. bisignatus *Say.*
C. fuscatus *Lec.*
C. obtentus *Hbst.*
C. fallax *Lec.*
C. minutissimus *Lec.*
C. ferratus *Say.*

PIAZURUS.

P. oculatus *Say.*

COPTURUS.

C. quercus *Say.*
C. binotatus *Lec.*

ACOPTUS.

A. suturalis *Lec.*

TACHYGONUS.

T. tardipes *Lec.*

I have taken this very curious little beetle by beating white elm (*Ulmus americana*) into an inverted umbrella, June 19.

CRAPONIUS.

G. inæqualis *Say.*

CŒLIODES.

C. curtus *Gyll.*
C. asper *Lec.*
C. flavicaudis *Boh.*
C. acephalus *Say.*
C. nebulosus *Lec.*

CEUTORHYNCHUS.

C. rapæ *Gyll.*
C. sulcipennis *Lec.*
C. septentrionalis *Gyll.*
C. zimmermani *Gyll.*
C. erysimi *Fab.*

This last species I never observed here until 1892.

PELENOMUS.

P. sulcicollis *Fab.*

CŒLOGASTER.

C. zimmermani *Gyll.*

RHINONCUS.

R. percarpius *Linn.*
R. pyrrhopus *Lec.*
R. longulus Lec.

BARIS.

B. umbilicata *Lec.*
B. transversa *Say.*
B. tumescens *Lec.*
B. ærea *Boh.*

TRICHOBARIS.

T. trinotata *Say.*

PSEUDOBARIS.

P. angusta *Lec.*

GLYPTOBARIS.

G. rugicollis *Lec.*

AULOBARIS.

A. scolopax *Say.*

AMPELOGLYPTER.

A. sesostris *Lec.*
A. ater *Lec.*

MADARUS.

M. undulatus *Say.*

STETHOBARIS.

S. tubulatus *Say.*

CENTRINUS.

C. scutellum-album *Say.*
C. strigicollis *Casey.*
C. striatirostris *Lec.*
C. modestus *Boh.*
C. confusus *Boh.*
C. prolixus *Lec.*
C. perscitus *Hbst.*
C. picumnus *Hbst.*

LIMNOBARIS.

L. calva *Lec.*
L. rectirostris *Lec.*
L. punctifer *Casey.*

ZYGOBARIS.

T. subcalva *Lec.*

BARINUS.

B. cribricollis *Lec.*

EUCHLETES.

E. echidna *Lec.*

This curious little porcupine weevil was in clusters on trunk of a dead beech tree, Sept. 27, 1900. I took one cluster of 30. They very closely resemble the color of the bark.

PLOCAMUS.

P. hispidulus *Lec.*

BALANINUS.

B. nasicus *Say.*
B. caryæ *Horn.*
B. quercus *Horn.*
B. uniformis *Lec.*

BRENTHIDÆ.

EUPSALIS.

E. minuta *Drury.*

This is the only representative we have here of the array of strange looking elongate forms that are found in tropical countries. We have in the extreme South and S. West three species

of *Brenthus*. *Eupsalis* lives under bark. I have found many under the bark of a buckeye tree. The male has the mouth parts shaped like pincers, quite different from the straight beak of the female.

CALANDRIDÆ.

RHODOBÆNUS.

R. tredecimpunctatus *Ill.*

SPHENOPHORUS.

S. zeæ *Walsh.*
S. callosus *Oliv.*
S. melanocephalus *Fabr.*
S. parvulus *Gyll.*
S. sayi *Gyll.*

CALANDRA.

C. oryzae *Linn.*
C. remotepunctata *Gyll.*
C. granaria *Fab.*

DRYOPHTHORUS.

D. americanus *Bedel.*

DRYOTRIBUS.

D. mimeticus *Horn.*

TYPHLOGLYMMA.

T. puteolatum *Dury.*

This was described by me in this journal, March 27, 1901.

HIMATIUM.

H. errans *Lec.*

COSSONUS.

C. platalea *Say.*
C. corticola *Say.*
C. concinnus *Boh.*
C. several unnamed species.

ALLOMIMUS.

A. dubius *Horn.*

STENOMIMUS.

S. pallidus *Boh.*

WOLLASTONIA.

W. quercicola *Boh.*

AMAURORHINUS.

A. nitens *Horn.*

PHLŒOPHAGUS.

P. minor *Horn.*

STENOSCELIS.

S. brevis *Boh.*

SCOLYTIDÆ.

A large family, some of them very destructive to timber.

PLATYPUS.

P. compositus *Say.*

MONARTHRUM.

M. fasciatum *Say.*

M. mali *Fitch.*

PITYOPHTHORUS.

P. pullus *Zimm.*

HYPOTHENEMUS.

H. eruditus *West.*

XYLOTERUS.

X. politus *Say.*

XYLEBORUS.

X. celsus *Eich.*

X. xylographus *Say.*

X. pubescens *Zimm.*

X. cælatus *Eich.*

TOMICUS.

T. calligraphus *Germ.*

MICRACIS.

M. rudis *Lec.*

THYSANOES.

T. fimbricornis *Lec.*

SCOLYTUS.

S. quadrispinosus *Say.*

S. muticus *Say.*

S. rugulosus *Ritz.*

CHRAMESUS.

C. icoriæ *Lec.*

PHLŒOTRIBUS.

P. liminaris *Harris.*

P. frontalis *Oliv.*

P. liminaris has been taken on the "bladder nut" (*Staphylea trifoliata*) by Prof. Hine.

CNESINUS.

C. strigicollis *Lec.*

DENDROCTONUS.

D. terebrans *Lec.*

CRYPTURGUS.

C. atomus *Lec.*

HYLESINUS.

H. aculeatus *Say*.
H. sericeus *Mann*.
H. fasciatus *Say*.

HYLASTES.

H. rufipes *Eich*.

H. rufipes is the same as *Hylesinus opaculus* of the check list. See Proc. Nat. Musuem, vol. 18, p. 605.

ANTHRIBIDÆ.

EURYMYCTER.

E. fasciatus *Oliv*.

TROPIDERES.

T. bimaculatus *Oliv*.
T. rectus *Lec*.

ALLANDRUS.

A. bifasciatus *Lec*.

HORMISCUS.

H. saltator *Lec*.

TOXOTROPIS.

T. pusillus *Lec*.

EUSPHYRUS.

E. walshii *Lec*.

I have taken these last three species on osage orange.

PIEZOCORYNUS.

P. dispar *Gyll*.
P. mixtus *Lec*.

ANTHRIBUS.

A. cornutus *Say*.

CRATOPARIS.

C. lunatus *Fab*.

BRACHYTARSUS.

B. alternatus *Say*.
B. tomentosus *Say*.
B. variegatus *Say*.

ARÆOCERUS.

A. fasciculatus *De G*.

Found in coffee berries.

CHORAGUS.

C. sayii *Lec*.

Several unidentified species of *Scolytids* and *Anthribids* probably new.

INDEX.

ARTICLE VI.—CHECK LIST OF HAMILTON COUNTY, OHIO, PLANTS, EXCLUSIVE OF THE LOWER CRYPTOGAMS.

BY WALTER H. AIKEN.

HAMILTON COUNTY in area is one of the smaller counties of the State of Ohio. It includes about three hundred and ninety square miles. The county is remarkably well watered and fertile. The underlying rocks of the Miami country are calcareous, and even the drift gravels are usually composed largely of limestone. From both of these sources fertilizing elements are imparted to the soil.

The low water in the Ohio River at Cincinnati is 431.96 feet above the mean tide at Sandy Hook, and the hills on the Ohio side (Walnut Hills, College Hill, and Price Hill) rise from 450 to 470 feet above the river.

The latitude of Cincinnati (the old Observatory) is 39° 6′ 26″ N., its longitude 84° 28′ W.

The surface of the county is drained by many small rivers and streams, the principal being the Big Miami, Little Miami, Dry Fork of Whitewater, Mill Creek, Duck Creek, Taylor Creek, and Blue Rock Creek.

North of the present city limits is a spacious basin or amphitheater of about twenty-five square miles, into which the suburbs are fast extending. As the city and its suburbs are thus expanding, the ponds and morasses of years ago are fast disappearing, and a great change in the flora of this region has resulted.

The climate of the county is mild and genial. The average mean temperature of the year is 52.5° Fht. The average annual rainfall in the last thirty-three years has been 38.36 inches.

In the following check list many new accessions to the Cincinnati Flora will be noticed, largely attributable to the numerous railways which center here from all parts of the continent, and possibly to the accidental importation of seeds of weeds mixed in among the seeds of foreign garden plants.

Many cultivated plants from public parks and private gardens have been added to the list, because such plants are frequently brought into the class-rooms of our schools as material for study. All the species enumerated, not considered to be natives of the region, have their respective native countries indicated.

The following sources have been consulted in compiling the catalogue, viz.:

1.—Synopsis of the Flora of the Western States. By John L. Riddell. (1835.)

2.—Catalogue of Plants, native and naturalized, collected in the vicinity of Cincinnati, Ohio, during the years 1834–1844. By Thos. G. Lea. (1849.)

3.—Catalogue of Flowering Plants and Ferns observed in the vicinity of Cincinnati. By Joseph Clark. Addenda by Robert Buchanan. (1852.)

4.—Catalogue of the Flowering Plants, Ferns, and Fungi growing in the vicinity of Cincinnati. By Joseph F. James. (1879.)

5.—Additions and Corrections to the Catalogue of Joseph F. James. By Davis L. James. (1881.)

6.—List of Plants observed growing wild in the vicinity of Cincinnati, Ohio. By C. G. Lloyd. (1891.)

7.—Catalogue of Ohio Plants. By Professor W. A. Kellerman and Wm. C. Werner, of Ohio State University. Vol. VII, Ohio Geological Reports. (1893.)

8.—My own private collection of upward of 800 Phaenogamous Plants, gathered in the vicinity of Cincinnati since 1895.

9.—The private collection of Miss Lucy Braun, gathered in 1903, which collection contains many species rare in this locality, and is especially rich in the river flora.

10.—The author has also had the privilege of examining many hundred of the collections of the pupils of the Cincinnati High Schools during the past years, covering very fully our Spring Flora.

CHECK LIST.

1904.

OPHIOGLOSSACEAE

Botrychium
MOONWORT.
dissectum Spreng.
obliquum Muhl.
Virginianum (L.) Sw.

Ophioglossum
ADDER'S TONGUE.
vulgatum L. N. U. S.

OSMUNDACEAE

Osmunda
FLOWERING FERN.
cinnamomea L.
Claytoniana L.
regalis L.

POLYPODIACEAE

Filix
(*Cystopteris*)
BLADDER FERN.
bulbifera (L.) Underw.
fragilis (L.) Underw.

Onoclea
sensibilis L.

Dryopteris
(*Aspidium* in part)
SHIELD FERN.
Goldieana (Hook.) A. Gray
N. E. U. S.
marginalis (L.) A. Gray
Noveboracensis (L.) A. Gray
spinulosa intermedia (Muhl.)
Underw. N. U. S.
Thelypteris (L.) A. Gray.

Phegopteris
BEECH FERN.
hexagonoptera (Michx.) Fee
Phegopteris (L.) Underw.
(*P. polypodioides* Fee)

Polystichum
(*Aspidium* in part)
acrostichoides (Michx.) Schott

Camptosorus
WALKING LEAF.
rhizophyllus (L.) Link

Asplenium
SPLEENWORT.
acrostichoides Sw.
(*A. thelypteroides* Michx.)
N. E. U. S.
angustifolium Michx.
Filix-foemina (L.) Bernh.
platyneuron (L.) Oakes
(*A. ebeneum* Ait.)
Trichomanes L.

Adiantum
MAIDEN HAIR FERN.
pedatum L.

Pteridium
(*Pteris* in part)
BRAKE.
aquilinum (L.) Kuhn

Polypodium
POLYPODY.
polypodioides (L.) A. S. Hitchc
(*P. incanum* Sw.)

SALVINIACEAE

Azolla
Caroliniana Willd.

EQUISETACEAE

Equisetum

HORSETAIL.

arvense L. N. U. S.

fluviatile L.

(*E. limosum* L.) N. U. S.

hyemale L.

sylvaticum L.

TAXACEAE

Taxus

YEW.

minor (Michx.) Britton

(*T. Canadensis* Willd.) N. U. S.

Ginko

MAIDEN-HAIR TREE.

biloba L. China.

PINACEAE

Pinus

WHITE PINE.

Strobus L. N. E. U. S.

Larix

LARCH.

laricina (Du Roi) Koch.

(*L. Americana* Michx.)

N. E. U. S.

Thuja

ARBOR VITAE.

occidentalis L. N. E. U. S.

Juniperus

JUNIPER, RED CEDAR.

Virginiana L.

TYPHACEAE

Typha

CAT-TAIL.

latifolia L.

SPARGANIACEAE

Sparganium

BUR-REED.

androcladum (Engelm.) Morong

POTAMOGETONACEAE

Potamogeton

POND-WEED.

foliosus Raf.

(*P. pauciflorus* Purch

natans L.

pectinatus L.

Zannichellia

HORNED POND-WEED.

palustris L.

ALISMACEAE

Alisma

WATER PLANTAIN.

Plantago-aquatica L.

Sagittaria

ARROW-HEAD.

latifolia Willd.

(*S. variabilis* Engelm.)

HYDROCHARIDACEAE

Philotria

(*Elodea*)

Canadensis (Michx.) Britton

GRAMINEAE

Andropogon

BEARD GRASS.

furcatus Muhl.

scoparius Michx.

Virginicus L.

Sorghum

Halepense (L.) Pers. Asia

Chrysopogon

avenaceus (Michx.) Benth.

Paspalum

laeve Michx.

setaceum Michx.

Panicum

WITCH GRASS.

capillare L.

clandestinum L.

depauperatum Muhl.

dichotomum L.

linearifolium Scribn.

Porterianum Nash.

proliferum Lam.

virgatum L.

Echinochloa
(*Panicum* in part)
Crus-galli (L.) Beauv. Europe.

Syntherisma
(*Panicum* in part)
CRAB OR FINGER GRASS.
sanguinalis (L.) Dulac. Europe.

Chaetochloa
(*Setaria*, also *Ixophorus*, Nash)
BRISTLY FOXTAIL GRASS.
glauca (L.) Scribn.
FOXTAIL PIGEON GRASS. Europe
Italica (L.) Scribn. Europe.
verticillata (L.) Scribn. Europe.
viridis (L.) Scribn.
GREEN FOXTAIL. Europe.

Cenchrus
HEDGEHOG OR BURGRASS.
tribuloides L.

Zizania
INDIAN RICE. WATER OATS.
aquatica L.

Homalocenchrus
(*Leersia*)
oryzoides (L.) Poll.
Virginicus (Wild.) Britton

Phalaris.
REED CANARY GRASS.
arundinacea L. N. U. S.
Canariensis L. Europe.

Anthoxanthum
SWEET VERNAL GRASS.
odoratum L. Europe.

Aristida
TRIPLE-AWNED GRASS.
gracilis Ell.
purpurascens Poir.

Muhlenbergia
diffusa Schreb.
Mexicana (L.) Trin.
tenuiflora (Willd. B. S. P.)
(*M. Willdenovii* Trin.

Phleum
TIMOTHY.
pratense L. Europe

Alopecurus
pratensis L. Europe

Sporobolus
DROP-SEED GRASS.
neglectus Nash

Cinna
WOOD REED-GRASS.
arundinacea L.

Agrostis
BENT GRASS.
alba L. Europe
hyemalis (Walt.) B. S. P.
(*A. scabra* Willd.)
perennans (Walt.) Tuckerman

Avena
OAT.
sativa L. Europe
striata Michx.

Arrhenatherum
OAT GRASS
elatius (L.) Beauv. Europe
(*A. avenaceum* Beauv.)

Danthonia
WILD OAT GRASS.
spicata (L.) Beauv.

Spartina
CORD OR MARSH GRASS.
cynosuroides (L.) Willd.

Eleusine
Indica (L.) Gaertn. Asia

Tricuspis
(*Triodia* in part.)
sesleroides (Michx.) Torr.
(*Triodia cuprea* Jacq.)

Eragrostis
capillaris (L.) Nees
Frankii Steud.
hypnoides (L.) B. S. P.
(*E. reptans* Nees.)
major Host. Europe
pectinacea (Michx.) Steud.
pilosa (L.) Beauv. Europe
Purshii Schrad.

Eatonia

obtusata (Michx.) A. Gray

Pennsylvanica (DC.) A. Gray

Dactylis

ORCHARD-GRASS.

glomerata L. Europe

Poa

annua L. Asia

compressa L.

ENGLISH BLUE GRASS. Europe

pratensis L.

KENTUCKY BLUE GRASS.

sylvestris A. Gray

Panicularia

(*Glyceria*)

MANNA GRASS.

fluitans (L.) Kuntze N. U. S.

nervata (Willd.) Kuntze

Festuca

elatior L.

MEADOW FESCUE. Europe

nutans Willd.

Bromus

BROME GRASS.

ciliatus L.

racemosus L. Europe

secalinus L.

CHESS. CHEAT. Europe

Lolium

DARNEL.

perenne L. Europe

Agropyron

repens (L.) Beauv. Europe

Hordeum

SQUIRREL TAIL GRASS.

jubatum L. N. W. U. S.

nodosum L. W. U. S.

(*H. pratense* Huds.)

vulgare L. BARLEY. Europe

Elymus

WILD RYE.

Canadensis L.

striatus Willd.

Virginicus L.

Hystrix

BOTTLE-BRUSH GRASS.

(*Asprella*)

Hystrix (L.) Millsp.

CYPERACEAE

Dulichium

arundinaceum (L.) Britton

(*D. spathaceum* Pers.)

Cyperus

diandrus Torr.

esculentus L.

inflexus Muhl.

(*C. aristatus* Rottb.)

strigosus L.

Kyllinga

pumila Michx.

Scirpus

BULRUSH OR CLUBRUSH.

Americanus Pers.

(*S. pungens* Vahl.)

atrovirens Muhl.

lacustris L.

lineatus Michx.

Eleocharis

SPIKE-RUSH.

ovata (Roth) R. & S.

Fimbristylis

autumnalis (L.) R. & S.

Carex

SEDGE.

Albursina Sheldon

Careyana Torr. N. E. U. S.

cephalophora Muhl.

conjuncta Boott

crinita Lam.

cristatella Britton

Davisii Schwein. & Torr.

Frankii Kunth

(*C. stenolepis* Torr.)

granularis Muhl.

hystricina Muhl.

Jamesii Schwein.
laxiflora blanda (Dewey) Boott
laxiflora patulifolia (Dewey) Carey
lupulina Muhl.
muricata L. Europe
oligocarpa Schk.
Pennsylvanica Lam.
rosea Schk.
Shortiana Dewey
sparganioides Muhl.
triceps Michx.
varia Muhl.
vulpinoidea Michx.

ARACEAE

Acorus
SWEET FLAG.
Calamus L.

Spathyema
SKUNK CABBAGE.
(*Symplocarpus*)
foetida (L) Raf.

Arisaema
INDIAN TURNIP.
Dracontium (L.) Schott.
DRAGON-ROOT.
triphyllum (L.) Torr.

LEMNACEAE

Spirodela
polyrhiza (L.) Schleid

COMMELINACEAE

Commelina
nudiflora L.
Virginica L.

Tradescantia
SPIDERWORT.
pilosa J. G. C. Lehm.
Virginiana L.

JUNCACEAE

Juncus
RUSH. BOG-RUSH.
effusus L.
tenuis Willd.
Torreyi Coville. S. W. U. S.
(*J. nodosus* var. *megacephalus.*)

Juncoides
(*Luzula*)
WOOD-RUSH.
campestre (L.) Kuntze

LILIACEAE

Uvularia
BELLWORT
grandiflora J. E. Smith

Hemerocallis
DAY LILY.
fulva L. Europe

Allium
Canadense L.
WILD GARLIC.
cepa L.
CULTIVATED ONION.
cernuum Roth.
WILD ONION.
tricoccum Ait.
WILD LEEK. N. E. U. S.
sativum. C.Bauh. GARLIC. India

Lilium
Canadense L.
WILD YELLOW LILY.
superbum L.
TURK'S-CAP LILY.
tigrinum Andr. India

Erythronium
albidum Nutt.
WHITE DOG'S TOOTH VIOLET.
Americanum Ker.
YELLOW ADDER'S TONGUE.

Quamasia
(*Camassia*)
WILD HYACINTH.
esculenta (Ker) Coville
(*Camassia Fraseri* Torr.)

Ornithogalum
STAR OF BETHLEHEM.
umbellatum L. Europe

Muscari
GRAPE HYACINTH.
botryoides (L.) Mill. Europe

Yucca
YUCCA.
filamentosa L. W. U. S.

CONVALLARIACEAE

Asparagus
GARDEN ASPARAGUS.
officinalis L. Europe

Vagnera
(*Smilacina*)
FALSE SOLOMON'S SEAL.
racemosa (L.) Morong

Polygonatum
SOLOMON'S SEAL.
biflorum (Walt.) Ell.
commutatum (R. & S.) Dietr.
(*P. giganteum* Dietr.)

Convallaria
LILY-OF-THE-VALLEY.
majalis L.

Trillium
WAKE ROBIN.
cernuum L.
erectum L.
recurvatum Beck
sessile L.

SMILACEAE

Smilax
GREENBRIER.
ecirrhata (Engelm.) Wats.
glauca Walt.
herbacea L.
CARRION-FLOWER.
hispida Muhl.

AMARYLLIDACEAE

Hypoxis
STAR-GRASS.
hirsuta (L.) Coville
(*H. erecta* L.)

DIOSCOREACEAE

Dioscorea
YAM.
villosa L.

IRIDACEAE

Iris
FLOWER DE LUCE.
versicolor L.
BLUE-FLAG.

Sisyrinchium
BLUE-EYED GRASS.
graminoides Bicknell
(*S. anceps* of Gray's Manual, 6th Edition, not Cav.)

ORCHIDACEAE

Orchis
spectabilis L.
SHOWY ORCHIS.

Habenaria
peramoena A. Gray

Gyrostachys
(*Spiranthes*)
LADIES' TRESSES.
cernua (L.) Kuntze
gracilis Willd.

Leptorchis
(*Liparis*)
liliifolia (L.) Kuntze

Pogonia
trianthophora (Sw.) B. S. P.

Corallorhiza
CORAL-ROOT.
odontorhiza (Willd.) Nutt.
Wisteriana Conrad

Aplectrum

PUTTY-ROOT.

spicatum (Walt.) B. S. P.

(*A. hiemale* Nutt.)

SAURURACEAE

Saururus

LIZARD'S TAIL.

cernuus L.

JUGLANDACEAE

Juglans

cinerea L.

BUTTERNUT.

nigra L.

BLACK WALNUT.

Hicoria

(*Carya*)

HICKORY.

alba (L.) Britton

(*C. tomentosa* Nutt.)

glabra (Mill.) Britton

(*C. porcina* Nutt.)

laciniosa (Michx. f.) Sargent

(*C. sulcata* Nutt.)

minima (Marsh.) Britton

(*C. amara* Nutt.)

ovata (Mill.) Britton

SHELL-BARK

(*C. alba* Nutt.)

SALICACEAE

Populus

POPLAR. ASPEN.

alba L.

WHITE POPLAR. Europe

balsamifera candicans (Ait.) A. Gray

deltoides Marsh

(*P. monilifera* Ait.)

NECKLACE POPLAR.

dilatata Ait. Europe

grandidentata Michx.

tremuloides Michx. N. U. S.

Salix

WILLOW.

alba vitellina (L.) Koch Europe

Babylonica L.

WEEPING WILLOW. Asia

cordata Muhl.

discolor Muhl.

interior Rowlee

(*S. longifolia* Muhl.)

nigra Marsh.

BLACK WILLOW.

purpurea L. Europe

sericea Marsh.

SILKY WILLOW.

BETULACEAE

Carpinus

IRON-WOOD.

Caroliniana Walt.

Ostrya

AMERICAN HOP-HORNBEAM.

Virginiana (Mill.) Willd.

Corylus

HAZEL-NUT.

Americana Walt.

Betula

BIRCH.

populifolia Marsh.

WHITE BIRCH.

FAGACEAE

Fagus

BEECH.

Americana Sweet

(*F. ferruginea* Ait)

Castanea

pumila (L.) Mill.

CHINQUAPIN.

Quercus
acuminata (Michx.) Houba
(*Muhlenbergii* Engelm.)
alba L.
WHITE OAK.
coccinea Wang.
SCARLET OAK.
imbricaria Michx.
LAUREL OAK.
Leana Nutt.
macrocarpa Michx.
MOSSY-CUP OAK.
palustris Du Roi
platanoides (Lam.) Sudw.
(*bicolor* Willd.)
rubra L.
RED OAK.
velutina Lam.
(*tinctoria* Bartr.)

ULMACEAE

Ulmus
ELM.
Americana L.
pubescens Walt.
SLIPPERY OR RED ELM.
(*U. fulva* Michx.)
racemosa Thomas

Celtis
HACKBERRY.
occidentalis L.

MORACEAE

Morus
MULBERRY.
rubra L.

Toxylon
(*Maclura*)
OSAGE ORANGE.
pomiferum Raf. S. W. U. S.
(*M. aurantiaca* Nutt.)

Broussonetia
papyrifera (L.) Vent. Japan

Humulus
HOP.
Lupulus L.

Cannabis
HEMP.
sativa L. Europe

URTICACEAE

Urtica
NETTLE.
dioica Pursh Europe
gracilis Ait.

Urticastrum
(*Laportea*)
WOOD-NETTLE.
divaricatum (L.) Kuntze
(*L. Canadensis* Gaud.)

Adicea
(*Pilea*)
RICHWEED. CLEARWEED.
pumila (L.) Raf.

Boehmeria
FALSE NETTLE.
cylindrica (L.) Willd. E. U. S.

Parietaria
PELLITORY.
Pennsylvanica Muhl.

LORANTHACEAE

Phoradendron
FALSE MISTLETOE.
flavescens (Pursh) Nutt.

SANTALACEAE

Comandra
umbellata (L.) Nutt.

ARISTOLOCHIACEAE

Asarum
WILD GINGER.
Canadense L.
reflexum Bicknell

Aristolochia
BIRTHWORT.
Serpentaria L.

POLYGONACEAE

Rumex

acetosella L.
FIELD OR SHEEP SORREL. Europe
altissimus Wood.
crispus L.
CURLED DOCK. Europe
obtusifolius L.
BITTER DOCK. Europe

Polygonum

KNOTWEED.
aviculare L.
Convolvulus L.
BLACK BINDWEED. Europe
erectum L.
Hydropiper L.
COMMON SMARTWEED. Europe
hydropiperoides Michx.
incarnatum Ell.
orientale L. India
Pennsylvanicum L.
Persicaria L.
LADY'S THUMB. Europe.
punctatum Ell.
(*P. acre* H. B. K.
sagittatum L.
scandens L.
Virginianum L.

Fagopyrum

BUCKWHEAT.
Fagopyrum (L.) Karst.
(*F. esculentum* Moench.) Europe

CHENOPODIACEAE

Chenopodium

album L.
LAMB'S-QUARTERS. Europe
ambrosioides L.
MEXICAN TEA. Trop. Amer.
Boscianum Moq.
Botrys L. Europe & Asia
glaucum L. Europe
murale L. Europe
urbicum L. Europe

Atriplex

ORACHE.
hastata L. W. U. S.
patula L.

AMARANTHACEAE

Amaranthus

AMARANTH.
graecizans L.
TUMBLE WEED. Asia
hybridus L. Trop. Amer.
(*A. chlorostachys* Willd.)
hybridus paniculatus (L.) U. & B.
Trop. Amer.
retroflexus L. Trop. Amer.
spinosus L.
THORNY AMARANTH. S. U. S.

Iresine

paniculata (L.) Kuntze
(*I. celosioides* L.)

Acnida

tamariscina tuberculata Moq.
S. W. U. S.

PHYTOLACCACEAE

Phytolacca

POKEWEED.
decandra L.

NYCTAGINACEAE

Allionia

(*Oxybaphus*)
FOUR O'CLOCK.
nyctaginea Michx. W. U. S.

AIZOACEAE

Mollugo

INDIAN CHICKWEED.
verticillata L. S. W. U. S.

PORTULACACEAE

Claytonia

SPRING BEAUTY.
Caroliniana Michx.
Virginica L.

Portulaca
GARDEN PORTULACA.
grandiflora Hook.
oleracea L.
PURSLANE. S. W. U. S.

CARYOPHYLLACEAE

Agrostemma
CORN COCKLE.
Githago L. Europe, N. Asia
(*Lychnis Githago* Lam.)

Silene
CATCHFLY. CAMPION.
alba Muhl.
(*S. nivea* Otth)
antirrhina L.
Caroliniana Walt.
(*S. Pennsylvanica* Michx.
stellata (L.) Ait. f.
STARRY CAMPION.
Virginica L.
FIRE PINK. CATCHFLY.
vulgaris (Moench) Garcke. Europe

Lychnis
COCKLE.
dioica L. Europe
(*L. diurna* Sibth.)

Saponaria
BOUNCING BET.
officinalis L. Europe

Alsine
(*Stellaria*)
CHICKWEED.
media L. Europe
pubera (Michx.) Britton

Cerastium
CHICKWEED.
arvense L.
longipedunculatum Muhl.
(*C. nutans* Raf.)
viscosum L. Europe
vulgatum L. Europe

Holosteum
umbellatum L. Europe

Arenaria
SANDWORT.
serpyllifolia L. Europe

Anychia
FORKED CHICKWEED.
Canadensis (L.) B. S. P.
(*A. capillacea* DC.)
dichotoma Michx.

NYMPHAEACEAE

Nymphaea
(*Nuphar*)
YELLOW POND LILY.
advena Soland

Castalia
(*Nymphaea*)
WATER LILY.
odorata (Dryand) Wood.

CERATOPHYLLACEAE

Ceratophyllum
HORNWORT.
demersum L.

MAGNOLIACEAE

Magnolia
CUCUMBER TREE.
acuminata L.
Fraseri Walt.

Liriodendron
TULIP TREE.
Tulipifera L.

ANNONACEAE

Asimina
PAPAW.
triloba (L.) Dunal

RANUNCULACEAE

Hydrastis
ORANGE ROOT.
Canadensis L.

Caltha
MARSH MARIGOLD.
palustris L.

Isopyrum
biternatum (Raf.) T. & G.

Actaea
WHITE BANEBERRY.
alba (L.) Mill.

Cimicifuga
BLACK SNAKEROOT. BLACK COHOSH.
racemosa (L.) Nutt.

Aquilegia
COLUMBINE.
Canadensis L.
vulgaris L. Europe

Delphinium
LARKSPUR
Ajacis L. Europe
Carolinianum Walt.
(*D. azureum* Michx.)
tricorne Michx.
DWARF LARKSPUR. S. W. U. S.

Anemone
WIND-FLOWER.
Canadensis L.
(*A. Pennsylvanaica* L.)
Virginiana L.

Hepatica
LIVER-LEAF.
acuta (Pursh) Britton
(*H. acutiloba* DC.)

Syndesmon
(*Anemonella*)
thalictroides (L.) Hoffm.

Clematis
VIRGIN'S-BOWER.
Viorna L.
LEATHER-FLOWER.
Virginiana L.

Ranunculus
CROWFOOT. BUTTERCUP.
abortivus L.
SMALL-FLOWERED CROWFOOT.
micranthus Nutt.
recurvatus Poir.
repens L. Europe
sceleratus L.
CURSED CROWFOOT. N. E. U. S.
septentrionalis Poir.

Thalictrum
MEADOW-RUE.
dioicum L.
polygamum Muhl. E. U. S.
purpurascens L.
PURPLISH MEADOW-RUE. N. E. U. S.

Batrachium
(*Ranunculus* in part.)
trichophyllum (Chaix) Bossch
(*Ranunculus circinatus* Sibth)

BERBERIDACEAE

Podophyllum
MAY APPLE.
peltatum L.

Jeffersonia
TWIN-LEAF.
diphylla (L.) Pers.

Caulophyllum
BLUE COHOSH.
thalictroides (L.) Michx.

Berberis
BARBERRY.
vulgaris L. Europe

MENISPERMACEAE

Menispermum
MOONSEED
Canadense L.

LAURACEAE

Sassafras

Sassafras (L.) Karst.
(*S. officinale* Nees & Eberm.)

Benzoin

(*Lindera*)
FEVER-BUSH. WILD-ALLSPICE.
Benzoin (L.) Coult.

PAPAVERACEAE

Sanguinaria

BLOOD-ROOT.
Canadensis L.

Stylophorum

CELANDINE POPPY.
diphyllum (Michx.) Nutt.
W. U. S.

Chelidonium

CELANDINE.
majus L. Europe

Argemone

MEXICAN POPPY.
Mexicana L. Trop. Amer.

Papaver

COMMON POPPY.
Argemone L.
somniferum L. Europe

FUMARIACEAE

Bicuculla

(*Dicentra*)
Canadensis (Goldie) Millsp.
SQUIRREL CORN.
Cucullaria (L.) Millsp.
DUTCHMAN'S BREECHES.

Capnoides

(*Corydalis*)
CORYDALIS
flavulum (Raf.) Kuntze

CRUCIFERAE

Lepidium

PEPPERGRASS
campestre (L.) R. Br. Europe
ENGLISH PEPPERGRASS.
ruderale L. Europe
Virginicum L.

Sisymbrium

HEDGE MUSTARD.
officinale (L.) Scop. Europe

Brassica

campestris L. Europe
TURNIP.
nigra (L.) Koch. Europe
BLACK MUSTARD.

Raphanus

GARDEN RADISH.
sativus L. Europe

Barbarea

WINTER CRESS.
Barbarea (L.) MacM. Europe
(*B. vulgaris* R. Br.

Roripa

(*Nasturtium*)
Armoracia (L.) A. S. Hitchc.
Europe
HORSE RADISH.
Nasturtium (L.) Rusby. Europe
(*N. officinale* R. Br.)
WATER CRESS.
palustris (L.) Bess.
MARSH CRESS.

Cardamine

hirsuta L.
BITTER CRESS.
purpurea (Torr.) Britton

Dentaria

TOOTHWORT.
diphylla Michx.
PEPPER ROOT.
laciniata Muhl.
CUT-LEAVED TOOTHWORT.

Bursa
SHEPHERD'S PURSE.
Bursa-Pastoris (L.) Brit.
(*Capsella*) Europe

Draba
WHITLOW GRASS.
verna L. Europe

Sophia
pinnata (Walt.) Howell.
(*Sisymbrium canescens* Nutt.

Arabis
ROCK CRESS.
Canadensis L.
SICKLE-POD.
glabra (L.) Bernh.
TOWER MUSTARD.
(*A. perfoliata* Lam.)
hirsuta (L.) Scop.
laevigata (Muhl.) Poir.

Iodanthus
dentatus (T. & G.) Greene
(*Arabis dentata* T. & G.)
pinnatifidus (Michx.) Steud
(*Thelypodium pinnatifidum*)

Cheiranthus
(*Erysimum*)
WORM-SEED MUSTARD.
cheiranthoides (L.) Heller

Konig
maritima (L.) R. Br. Europe
(*Alyssum maritimum* L.)

Hesperis
DAME'S VIOLET.
matronalis L. Europe

CAPPARIDACEAE

Polanisia
CLAMMY WEED.
graveolens Raf. W. U. S.

RESEDACEAE

Reseda
MIGNONETTE.
odorata L. Europe.

CRASSULACEAE

Sedum
STONE-CROP. ORPINE.
telephioides Michx. S. E. U. S.
ternatum Michx. South E. U. S.

Penthorum
DITCH STONE-CROP.
sedoides L.

SAXIFRAGACEAE

Saxifraga
SAXIFRAGE.
Virginiensis Michx. N. E. U. S.

Heuchera
ALUM ROOT.
Americana L.

Mitella
MITRE-WORT. BISHOP'S-CAP.
diphylla L.

HYDRANGEACEAE

Philadelphus
MOCK-ORANGE or SYRINGA.
coronarius L. Europe
inodorus L. Europe.

Hydrangea
arborescens L.
WILD HYDRANGEA.

GROSSULARIACEAE

Ribes
aureum Pursh
MISSOURI CURRANT. W. U. S.
Cynosbati L.
WILD GOOSEBERRY. N. E. U. S.
rubrum L. Europe

HAMAMELIDACEAE

Liquidambar
SWEET GUM TREE.
Styraciflua L.

Hamamelis
WITCH-HAZEL.
Virginiana L.

PLATANACEAE

Platanus
SYCAMORE. BUTTON-WOOD.
occidentalis L.

ROSACEAE

Opulaster
(*Physocarpus*)
opulifolius (L.) Kuntze

Spiraea
MEADOW-SWEET.
salicifolia L.

Porteranthus
(*Gillenia*)
INDIAN PHYSIC.
stipulatus (Muhl.) Britton
S. W. U. S.

Rubus
Canadensis L.
DEWBERRY.
occidentalis L.
BLACK RASPBERRY.
villosus Ait.
BLACKBERRY.

Fragaria
STRAWBERRY.
Virginiana Duchesne
(*F. Virginiana* var. *Illinoensis*)

Potentilla
CINQUE-FOIL. FIVE-FINGER.
Canadensis L.
Monspeliensis L.
(*P. Norwegica*)
recta L. Europe Asia

Drymocallis
(*Potentilla* in part)
arguta (Pursh) Rydb.

Geum
AVENS.
Canadense Jacq.
(*G. album* Gmel.)
vernum (Raf.) T. & G.
Virginianum L.

Agrimonia
AGRIMONY.
mollis (T. & G.) Britton

Rosa
ROSE.
blanda Ait.
humilis Marsh.
rubiginosa L.
SWEET BRIAR. Europe
setigera Michx.

POMACEAE

Malus
(*Pyrus in part*)
APPLE.
coronaria (L.) Mill.
CRAB-APPLE.
Malus (L.) Britton Europe

Amelanchier
JUNE-BERRY.
Canadensis (L.) Medic.

Crataegus
HAWTHORN. WHITE THORN.
coccinea L.
Crus-galli L.
mollis (T. & G.) Scheele.
Oxyacantha L. Europe
punctata Jacq.

DRUPACEAE

Prunus
PLUM, CHERRY.
Americana Marsh.
mahaleb L.
serotina Ehrh.

Amygdalus
PEACH.
Persica L. Asia

CAESALPINACEAE

Cercis
RED-BUD. JUDAS-TREE.
Canadensis L.

Cassia
SENNA.
Marylandica L.

Chamaecrista
(*Cassia* in part)
PARTRIDGE PEA.
fascicularis (Michx.) Greene
(*Cassia chamaecrista* L.)

Gleditsia
triacanthos L.
HONEY LOCUST.

Gymnocladus
KENTUCKY COFFEE-TREE.
dioicus (L.) Koch.
(*G. Canadensis* Lam.)

PAPILIONACEAE

Cladrastis
YELLOW-WOOD.
lutea (Michx. f.) Koch
(*C. tinctoria* Raf.)

Baptisia
INDIGO.
australis (L.) R. Br.
FALSE INDIGO. S. W. U. S.
tinctoria (L.) R. Br.
WILD INDIGO.

Medicago
MEDICK.
lupulina L.
BLACK MEDICK. Europe
Sativa L.
LUCERNE. ALFALFA. Europe

Melilotus
SWEET CLOVER, MELILOT.
alba Desv. Europe
officinalis (L.) Lam. Europe

Trifolium
CLOVER.
arvense L.
RABBIT-FOOT. Europe
incarnatum L. Europe
pratense L.
RED CLOVER. Europe
repens L.
WHITE CLOVER. Europe
stoloniferum Muhl.
BUFFALO CLOVER. W. U. S.

Chrysaspis
(*Trifolium* in part)
agraria (L.) Greene Europe

Psoralea
Onobrychis Nutt.

Amorpha
HOARY PEA.
fruticosa L.

Cracca
(*Tephrosia*)
Virginiana L.

Kraunhia
(*Wisteria*)
WISTERIA.
frutescens (L.) Greene

Robinia
LOCUST-TREE.
Pseudacacia L. S. U. S.

Astragalus
Carolinianus L.
(*A. Canadensis* L.

Phaca
(*Astragalus* in part)
neglecta T. & G.

Meibomia

(*Desmodium*)

Tick-trefoil.

bracteosa (Michx.) Kuntze

(*D. cuspidatum* Hook.)

canescens (L.) Kuntze

Dillenii (Darl.) Kuntze

grandiflora (Walt.) Kuntze

(*D. acuminatum* DC.)

Michauxii Vail

(*D. rotundifolium* DC.)

nudiflora (L.) Kuntze

paniculata (L.) Kuntze

pauciflora (Nutt) Kuntze

Lespedeza

Bush-clover.

procumbens Michx.

Vicia

Vetch. Tare.

sativa L. Europe

Falcata

(*Amphicarpaea*)

Hog Pea-nut.

comosa (L.) Kuntze

(*A. monoica* Nutt.)

Strophostyles

(*Phaseolus* in part)

Kidney Bean.

helvola (L.) Britton

(*S. angulosa* Ell.)

GERANIACEAE

Geranium

Cranesbill.

Carolinianum L.

maculatum L.

Wild Cranesbill.

OXALIDACEAE

Oxalis

Wood-Sorrel.

grandis Small

stricta L.

Yellow Wood-Sorrel.

violacea L

Violet Wood-Sorrel.

LINACEAE

Linum

Flax.

usitatissimum L. Europe.

RUTACEAE

Xanthoxylum

Prickly Ash.

Americanum Mill.

Ptelea

Hop-Tree. Shrubby Trefoil.

trifoliata L.

SIMARUBACEAE

Ailanthus

Tree of Heaven.

glandulosus Desf. China

POLYGALACEAE

Polygala

Milkwort.

Senega L.

Seneca Snakeroot.

viridescens L.

(*P. sanguinea* L.

EUPHORBIACEAE

Phyllanthus

Carolinensis Walt.

Croton

capitatus Michx. S. W. U. S.

Acalypha

Three-Seeded Mercury.

Virginica L.

Ricinus
CASTOR OIL PLANT.
communis L. Africa

Euphorbia
SPURGE.
commutata Engelm.
corollata L.
Cyparissias L. Europe.
dentata Michx. S. W. U. S.
maculata L.
marginata Pursh. S. W. U. S.
obtusata Pursh. S. W. U. S.
Preslii Guss.
(*E. nutans* of authors, not Lag.)

CALLITRICHACEAE

Callitriche
WATER STAR-WORT.
Austini Engelm.

LIMNANTHACEAE

Floerkea
proserpinacoides Willd.

ANACARDIACEAE

Cotinus
SMOKE TREE.
cotinoides (Nutt.) Britton
(*Rhus cotinoides* Nutt.)

Rhus
SUMACH.
copallina L.
DWARF SUMACH.
glabra L.
SMOOTH SUMACH.
hirta (L.) Sudw.
STAGHORN SUMACH.
(*R. typhina* L.)
radicans L.
POISON IVY. POISON OAK.

AQUIFOLIACEAE

Ilex
opaca Ait.
AMERICAN HOLLY.
verticillata (L.) A. Gray
BLACK ALDER.

CELASTRACEAE

Euonymus
SPINDLE-TREE.
atropurpureus Jacq.
WAAHOO.
obovatus Nutt.

Celastrus
SHRUBBY BITTER-SWEET.
scandens L.

STAPHYLEACEAE

Staphylea
trifolia L.

ACERACEAE

Acer
MAPLE.
Negundo L.
BOX-ELDER.
(*Negundo aceroides* Moench)
nigrum Michx.
platanoides L.
rubrum L.
RED OR SWAMP MAPLE.
saccharinum L.
SILVER MAPLE.
(*A. dasycarpum* Ehrh.)
saccharum Marsh.
SUGAR OR ROCK MAPLE.
(*A. saccharinum* Wang.)

HIPPOCASTANACEAE

Aesculus
BUCKEYE.
glabra Willd.
FETID OR OHIO BUCKEYE.
Hippocastanum L.
HORSE CHESTNUT. Asia
octandra Marsh.
SWEET BUCKEYE.
(*A. flava* Ait.) S. W. U. S.
hybrida (DC.) Sargent
(*A. flava* var. *purpurascens*)

Koelreuteria
paniculata Laxm. Japan

SAPINDACEAE

Cardiospermum
HEART-SEED. BALLOON PEA.
Halicacabum L. Trop. Amer.

BALSAMINACEAE

Impatiens
JEWEL WEED BALSAM.
aurea Muhl.
(*I. pallida* Nutt.)
biflora Walt.
(*I. fulva* Nutt.)

RHAMNACEAE

Rhamnus
BUCKTHORN.
lanceolata Pursh. S. W. U. S.

Ceanothus
NEW JERSEY TEA.
Americanus L.

VITACEAE

Vitis
aestivalis Michx.
SUMMER GRAPE.
cordifolia Michx.
FROST OR CHICKEN GRAPE.

Parthenocissus
(*Ampelopsis* in part)
VIRGINIA CREEPER.
quinquefolia (L.) Planch.

Ampelopsis
arborea (L.) Rusby
(*Cissus stans* Pers.)

TILIACEAE

Tilia
LINDEN. BASSWOOD.
Americana L.
heterophylla Vent.
WHITE BASSWOOD.

MALVACEAE

Abutilon
INDIAN MALLOW.
Abutilon (L.) Rusby. Asia
(*A. Avicennae* Gaertn.)

Malva
MALLOW.
rotundifolia L. Europe

Sida
spinosa L. Tropical America

Hibiscus
ROSE MALLOW.
militaris Cav. HALBERD-LEAVED ROSE-MALLOW
Syriacus L.
Trionum L.
BLADDER KETMIA. Europe

HYPERICACEAE

Ascyrum
ST. PETER'S WORT.
hypericoides L.
(*A. Crux-Andreae* L.)

Hypericum
ST. JOHN'S WORT.
Canadense L.
Drummondii (Grev. & Hook.)
maculatum Walt.
mutilum L.
prolificum L.

Sarothra
gentianoides L.
(*Hypericum nudicaule* Walt.

VIOLACEAE

Cubelium
(*Solea*)
GREEN VIOLET.
concolor (Forst.) Raf.

Viola
VIOLET.
Canadensis L.
odorata L.
obliqua Hill.
palmata L.
COMMON BLUE VIOLET.
pubescens Ait.
DOWNY YELLOW VIOLET.
Rafinesquii Greene
(*tricolor* var. *arvensis* DC.)
striata Ait.
PALE VIOLET.
tricolor L. PANSY. Europe

PASSIFLORACEAE

Passiflora
PASSION-FLOWER.
lutea L.

LYTHRACEAE

Rotala
ramosior (L.) Koehne

Lythrum
WING-ANGLED LOOSESTRIFE.
alatum Pursh

Parsonsia
(*Cuphea*)
petiolata (L.) Rusby
(*Cuphea viscosissima* Jacq.
CLAMMY CUPHEA.

MELASTOMACEAE

Rhexia
MEADOW BEAUTY.
Virginica L.

ONAGRACEAE

Ludwigia
FALSE LOOSE-STRIFE.
alternifolia L.
SEED BOX.

Isnardia
(*Ludwigia* in part)
WATER PURSLANE.
palustris L.

Epilobium
WILLOW-HERB.
coloratum Muhl.

Onagra
(*Oenothera* in part)
EVENING PRIMROSE.
biennis (L.) Scop.
grandiflora (Ait.) Lindl.

Gaura
biennis L.

Circaea
ENCHANTER'S NIGHT SHADE.
Lutetiana L.

ARALIACEAE

Panax
(*Aralia* in part)
GINSENG.
quinquefolium L.

Aralia
SPIKENARD.
racemosa L.

UMBELLIFERAE

Sanicula
BLACK SNAKE-ROOT.
Canadensis L.
Marylandica L.

Chaerophyllum
CHERVIL.
procumbens (L.) Crantz
Shortii T. & G.

Washingtonia
(*Osmorrhiza*)
SWEET CICELY.
Claytoni (Michx.) Britton
(*O. brevistylis* DC.)
longistylis (Torr.) Britton

Caucalis
HEDGE PARSLEY.
Anthriscus (L.) Huds. Europe

Erigenia
HARBINGER-OF-SPRING.
bulbosa (Michx.) Nutt.

Bupleurum
THOROUGHWORT.
rotundifolium L. Europe

Zizia
MEADOW PARSNIP.
aurea (L.) Koch

Cicuta
WATER-HEMLOCK.
bulbifera L. N. E. U. S.
maculata L.
SPOTTED COWBANE.

Deringa
(*Cryptotaenia*)
HONEWORT.
Canadensis (L.) Kuntze

Carum
CARAWAY.
Carui L. Europe

Taenidia
YELLOW PIMPERNEL.
integerrima (L.) Drude
(*Pimpinella integerrima* L.)

Thaspium
MEADOW-PARSNIP.
barbinode (Michx.) Nutt.
trifoliatum (L.) Britton

Pastinaca
PARSNIP.
sativa L. Europe

Daucus
CARROT.
Carota L. Europe

CORNACEAE

Nyssa
SOUR-GUM.
sylvatica Marsh.
(*N. multiflora* Wang.)

Cornus
DOGWOOD.
Amomum Mill.
(*C. sericea* L.)
asperifolia Michx.
candidissima Marsh.
(*C. paniculata* L'Her.)
florida L.

MONOTROPACEAE

Monotropa
INDIAN PIPE.
uniflora L.

PRIMULACEAE

Samolus
BROOK-WEED.
floribundus H. B. K.
(*S. Valerandi* var. *Americana*)

Lysimachia
LOOSESTRIFE.
nummularia L.
MONEYWORT. Europe
quadrifolia L.
terrestris (L.) B. S. P.
(*L. stricta* Ait.)

Steironema
ciliatum (L.) Raf.
lanceolatum (Walt.) A. Gray

Anagallis
PIMPERNEL.
arvensis L. Europe

Dodecatheon
AMERICAN COWSLIP.
Meadia L.

EBENACEAE

Diospyros

PERSIMMON.

Virginiana L.

OLEACEAE

Fraxinus

Americana L.

WHITE ASH.

nigra Marsh.

(*F. sambucifolia* Lam.)

BLACK ASH.

quadrangulata Michx.

BLUE ASH.

Syringa

LILAC.

vulgaris L. Europe

Chionanthus

FRINGE-TREE.

Virginica L.

Ligustrum

PRIVET.

vulgare L.

GENTIANACEAE

Sabbatia

angularis (L.) Pursh

Obolaria

PENNYWORT.

Virginica L.

Gentiana

GENTIAN.

Andrewsii Griseb

Frasera

AMERICAN COLUMBO.

Carolinensis Walt.

APOCYNACEAE

Vinca

minor L. Europe

Apocynum

DOGBANE. INDIAN HEMP.

androsaemifolium L.

cannabinum L.

ASCLEPIADACEAE

Asclepias

MILKWEED.

exaltata (L.) Muhl.

(*A. phytolaccoides* Pursh)

incarnata L.

quadrifolia Jacq.

Syriaca L.

(*A. Cornuti* Dec.)

tuberosa L.

BUTTERFLY-WEED.

PLEURISY-ROOT.

Gonolobus

(*Ampelanus; Enslenia*)

laevis Michx.

(*Enslenia albida* Nutt.)

Vincetoxicum

(*Gonolobus* of authors, not Michx.

gonocarpos Walt.

(*G. macrophyllus* Willd.)

obliquum (Jacq.) Britton

S. E. U. S.

CONVOLVULACEAE

Quamoclit

(*Ipomoea* in part)

coccinea (L.) Moench

Trop. Amer.

Ipomoea

MORNING GLORY.

hederacea (L.) Jacq.

Trop. Amer.

lacunosa L. S. W. U. S.

pandurata (L.) Meyer

WILD POTATO-VINE.

purpurea (L.) Roth

Trop. Amer.

Convolvulus

BINDWEED

arvensis L. Europe

sepium L.

HEDGE BINDWEED.

spithamaeus L.

CUSCUTACEAE

Cuscuta
DODDER.
arvensis Beyrich
Gronovii Willd.

POLEMONIACEAE

Phlox
divaricata L.
maculata L.
paniculata L.

Polemonium
GREEK VALERAIN.
reptans L.

HYDROPHYLLACEAE

Hydrophyllum
WATERLEAF.
appendiculatum Michx.
Canadense L.
macrophyllum Nutt.
Virginicum L.

Phacelia
bipinnatifida Michx. S.W. U. S.
Purshii Buckley

BORAGINACEAE

Heliotropium
HELIOTROPE.
Indicum L. India

Cynoglossum
HOUND'S-TONGUE.
officinale L. Europe
Virginicum L.
WILD COMFREY.

Lappula
(*Echinospermum*)
STICKSEED
Lappula (L.) Karst. Europe
Virginiana (L.) Greene

Mertensia
LUNGWORT.
Virginica (L.) DC.

Lithospermum
PUCCOON.
arvense L. Europe
canescens (Michx.) Lehm.
latifolium Michx.

Echium
BLUE-WEED.
vulgare L.

VERBENACEAE

Verbena
VERVAIN.
augustifolia Michx.
bracteosa Michx. W. U. S.
hastata L.
BLUE VERVAIN.
stricta Vent.
HOARY VERVAIN.
urticaefolia L.
WHITE VERVAIN.

Phyla
(*Lippia* in part)
FOG-FRUIT.
lanceolata (Michx.) Greene

LABIATAE

Teucrium
GERMANDER.
Canadense L.

Isanthus
FALSE PENNYROYAL.
brachiatus (L.) B. S. P.
(*I. coeruleus* Michx.)

Scutellaria
SKULLCAP.
cordifolia Muhl.
incana Muhl.
(*S. canescens.*)
lateriflora L.
nervosa Pursh
parvula Michx.

Marrubium
HOREHOUND.
vulgare L. Europe

Agastache
(*Lophanthus*)
GIANT HYSSOP.
nepetoides (L.) Kuntze
scrophulariaefolia (Willd.) Kuntze.

Nepeta
CAT-MINT.
Cataria L.
CATNIP. Europe

Glecoma
GROUND IVY.
hederacea L. Europe
(*Nepeta Glechoma* Benth.)

Prunella
SELF-HEAL.
vulgaris L. Europe

Synandra
hispidula (Michx.) Britton
(*S. grandiflora* Nutt.)

Lamium
DEAD-NETTLE.
amplexicaule L. Europe

Leonurus
MOTHERWORT.
Cardiaca L. Europe

Salvia
SAGE.
lyrata L.
officinalis L.
GARDEN SAGE. Europe

Stachys
HEDGE-NETTLE.
aspera Michx.
cordata Riddell S. E. U. S.
tenuifolia Willd.
(*S. aspera* var. *glabra* A. Gray)

Monarda
HORSE-MINT.
fistulosa L.

Blephilia
hirsuta (Pursh) Torr.

Hedeoma
MOCK PENNYROYAL.
pulegioides (L.) Pers.

Melissa
BALM.
officinalis L. Europe

Clinopodium
(*Calamintha*)
CALAMINT.
vulgare L.
(*C. Clinopodium* Benth.)

Koellia
(*Pycnanthemum*)
BASIL.
flexuosa (Walt.) MacM.
pilosa (Nutt.) Britton
Virginiana (L.) MacM.
(*P. lanceolatum* Pursh)

Lycopus
WATER-HOREHOUND.
Americanus Muhl.
(*L. sinuatus* Ell.)
Virginicus L.

Mentha
MINT.
Canadensis L. N. U. S.
piperita L.
PEPPERMINT. Europe
spicata L.
(*M. viriais* L.) Europe

Collinsonia
HORSE-BALM.
Canadensis L.

SOLANACEAE

Physalodes
(*Nicandra*)
APPLE OF PERU.
Physalodes (L.) Brit. South. Am.

Lycium
MATRIMONY VINE.
vulgare (Ait. f.) Dunal Europe

Physalis
GROUND CHERRY.
heterophylla Nees
pubescens L.
Virginiana Mill.

Solanum
NIGHTSHADE.
Carolinense L.
Dulcamara L. Europe
nigrum L.
rostratum Dunal W. U. S.
tuberosum L.

Lycopersicon
TOMATO.
Lycopersicon (L.) Karst.
(*L. esculentum* Mill.)
Trop. Amer.

Datura
JAMESTOWN WEED, JIMSON.
Stramonium L. Asia
Tatula L. Trop. Amer.

Nicotiana
TOBACCO.
Tabacum L. South Amer.

SCROPHULARIACEAE

Verbascum
MULLEIN.
Blattaria L. Europe
Thapsus L. Europe

Linaria
TOAD-FLAX.
Linaria (L.) Karst. Europe
(*L. vulgaris* Mill.)

Antirrhinum
Majus L. Europe

Collinsia
verna Nutt.

Scrophularia
Marylandica L.

Chelone
TURTLE-HEAD. SNAKE-HEAD.
glabra L.

Pentstemon
BEARD-TONGUE.
hirsutus (L.) Willd.
(*P. pubescens* Soland.)
Pentstemon (L.) Britton
(*P. laevigatus* Soland.)

Paulownia
tomentosa (Thurb.) Baill. Japan
(*P. imperialis* Sieb. & Zucc.)

Mimulus
MONKEY-FLOWER.
alatus Soland.
ringens L.

Gratiola
HEDGE HYSSOP.
Virginiana L.

Ilysanthes
FALSE PIMPERNEL.
dubia (L.) Barnhart
(*I. gratioloides* Benth.)

Veronica
SPEEDWELL.
peregrina L.
serpyllifolia L.

Leptandra
Virginica (L.) Nutt.
(*Veronica Virginica* (L.)

Digitalis
purpurea L. Europe

Afzelia
(*Seymeria*)
MULLEN FOXGLOVE.
macrophylla (Nutt.) Kuntze
W. U. S.

Gerardia
purpurea L.
tenuifolia Vahl.

Melampyrum
COW-WHEAT.
lineare Lam.
(*M. Americanum* Michx.)

Pedicularis
Canadensis L.
multifida (Mx.) Benth.

OROBANCHACEAE

Conopholis
SQUAW-ROOT.
Americana (L. f.) Wallr.

Orobanche
(*Aphyllon* in part)
NAKED BROOM-RAPE.
Ludoviciana Nutt.

Thalesia
(*Aphyllon*)
CANCER-ROOT.
uniflora (L.) Britton

Leptamnium
(*Epiphegus*)
BEECH-DROPS.
Virginianum (L.) Raf.

BIGNONIACEAE

Catalpa
Catalpa (L.) Karst. S. W. U. S.
(*C. bignonioides* Walt.)
speciosa Warder. S. W. U. S.

Campsis
TRUMPET-FLOWER.
radicans (L.) Seem.
(*Tecoma radicans* DC.)

MARTYNIACEAE

Martynia
UNICORN-PLANT.
Louisiana Mill. S. U. S.
(*M. proboscidea* Glox.)

ACANTHACEAE

Ruellia
strepens L. S. W. U. S.

Dianthera
WATER-WILLOW.
Americana L.

PHRYMACEAE

Phryma
LOPSEED.
Leptostachya L.

PLANTAGINACEAE

Plantago
PLANTAIN.
aristata Michx. W. U. S.
lanceolata L. Europe
Rugelii Dcne.
Virginica L.

RUBIACEAE

Houstonia
BLUETS. INNOCENCE.
ciliolata Torr.
coerulea L.
purpurea L. S. E. U. S.

Cephalanthus
BUTTON BUSH.
occidentalis L.

Spermacoce
BUTTON-WEED.
glabra Michx.

Diodia
teres Walt.

Sherardia
BLUE FIELD MADDER.
arvensis L. Europe

Asperula
WOODRUFF.
odorata L.

Galium
BEDSTRAW. CLEAVERS.
Aparine L.
GOOSE-GRASS. Europe
circaezans Michx.
WILD LIQUORICE.
concinnum T. & G.
triflorum Michx.
SWEET-SCENTED.
tinctorium L.

CAPRIFOLIACEAE

Sambucus
ELDER.
Canadensis L.

Viburnum
ARROW-WOOD.
acerifolium L. N. E. U. S.
Opulus L.
CRANBERRY-TREE.
prunifolium L.
BLACK HAW.

Triosteum
HORSE-GENTIAN.
angustifolium L.

Symphoricarpos
SNOW-BERRY.
Symphoricarpos (L.) MacM.
(*S. vulgaris* Michx.

Lonicera
HONEYSUCKLE.
sempervirens L.
Sullivantii A. Gray

VALERIANACEAE

Valerianella
LAMB LETTUCE.
radiata (L.) Dufr.

Valeriana
VALERIAN.
pauciflora Michx.

DIPSACEAE

Dipsacus
TEASEL.
sylvestris Huds. Europe

CUCURBITACEAE

Citrullus
WATER-MELON.
Citrullus (L.) Small. Europe
(*C. vulgaris* Schrad.)

Cucumis
Melo L. Asia

Lagenaria
Lagenaria (L.) Cockerell
(*L. vulgaris* Ser.)

Cucurbita
PUMPKIN.
Pepo L.
verrucosa L.

Micrampelis
(*Megarrhiza*)
WILD BALSAM APPLE.
lobata (Michx.) Greene
(*Echinocystis lobata* T. & G.)

Sicyos
ONE-SEEDED BUR-CUCUMBER.
angulatus L.

CAMPANULACEAE

Campanula

BELLFLOWER.

Americana L.
aparinoides Pursh
rapunculoides L.

Legouzia

(*Specularia*)
VENUS' LOOKING-GLASS.

perfoliata (L.) Britton

LOBELIACEAE

Lobelia

LOBELIA.

cardinalis L.
inflata L.
leptostachya A. DC.
spicata Lam.
syphilitica L.

COMPOSITAE

Vernonia

IRONWEED.

fasciculata Michx. S. W. U. S.

Elephantopus

ELEPHANT'S-FOOT.

Carolinianus Willd.

Eupatorium

THOROUGHWORT.

ageratoides L. f.
WHITE SNAKE-ROOT.
coelestinum L.
MIST-FLOWER.
perfoliatum L.
BONESET.
purpureum L.
JOE-PYE WEED.

Grindelia

GUM PLANT.

squarrosa (Pursh) Dunal.
W. U. S.

Solidago

GOLDEN-ROD.

caesia L.
Canadensis L.
flexicaule L.
(*S. latifolia* L.)
patula Muhl.
serotina Ait.
ulmifolia Muhl.

Euthamia

(*Solidago* in part)
BUSHY GOLDEN-ROD.

graminifolia (L.) Nutt.
(*S. lanceolata* L.)

Aster

STARWORT, ASTER.

cordifolius L.
divaricatus L.
(*A. corymbosus* Ait.)
ericoides pilosus (Willd.) Porter
lateriflorus (L.) Britton
(*A. diffusus* Ait.)
longifolius Lam.
macrophyllus L.
Nova-Angliae L.
paniculatus Lam.
phlogifolius Muhl.
prenanthoides Muhl.
puniceus L. Red stalked A.
Shortii Hook.
vimineus Lam.

Erigeron

FLEABANE.

annuus (L.) Pers.

Philadelphicus L.

pulchellus Michx.

(*E. bellidifolius* Muhl.)

ramosus (Walt.) B. S. P.

Antennaria

EVERLASTING.

fallax Greene

plantaginifolia (L.) Richards.

Anaphalis

margaritacea (L.) B. & H.

Gnaphalium

CUDWEED.

purpureum L.

uliginosum L. Europe

Inula

ELECAMPANE.

Helenium L. Europe

Polymnia

LEAF-CUP.

Canadensis L.

Uvedalia L.

Silphium

ROSIN-WEED.

perfoliatum L.

CUP-PLANT.

terebinthinaceum Jack.

PRAIRIE DOCK.

trifoliatum A. Gray S. E. U. S.

Ambrosia

RAGWEED.

artemisiaefolia L.

HOG-WEED.

trifida L.

GREAT RAG-WEED.

integrifolia (Muhl.) T. & G.

Xanthium

COCKLEBUR.

Canadense Mill.

spinosum L. Trop. Amer.

strumarium L. Europe

Heliopsis

OX-EYE.

helianthoides (L.) B. S. P.

(*H. laevis* Pers.)

Eclipta

alba (L.) Hassk. Trop. Amer.

Rudbeckia

CONE-FLOWER.

hirta L. W. U. S.

laciniata L.

triloba L.

Ratibida

(*Lepachys*)

GRAY-HEADED CONE FLOWER.

pinnata (Vent.) Barnhart

Helianthus

SUNFLOWER.

annuus L. W. U. S.

decapetalus L.

giganteus L.

hirsutus Raf.

strumosus L.

tuberosus L.

Verbesina

(Includes *Actinomeris*)

CROWNBEARD.

alternifolia (L.) Britton

(*A. squarrosa*)

helianthoides Michx. S.W.U.S.

Coreopsis

TICKSEED.

tinctoria Nutt.

tripteris L.

TALL COREOPSIS.

Bidens

Bur-Marigold.

bipinnata L.

connata Muhl.

Swamp Beggar Ticks.

frondosa L.

laevis (L.) B. S. P.

(*B. chrysanthemoides* Michx.)

trichosperma (Michx.) Britton

(*Coreopsis trichosp.* Michx.)

tenuiloba (A. Gray) Britton

Galinsoga

Galinsoga.

parviflora Cav. Europe

Helenium

Sneeze-weed.

autumnale L.

nudiflorum Nutt.

Dysodia

Fetid Marigold.

papposa (Vent.) A. S. Hitchc. S. W. U. S.

(*D. chrysanthemoides* Lag.)

Anthemis

Chamomile.

Cotula L. Europe

nobilis L. Europe.

Achillea

Yarrow. Milfoil

Millefolium L. Europe

Matricaria

Wild Chamomile.

matricarioides (Less.) Porter

(*M. discoidea* DC.) W. U. S.

Chrysanthemum

Ox-eye Daisy.

Leucanthemum L. Europe.

Parthenium (L.) Pers. Europe

Tanacetum

Tansy.

vulgare L. Europe.

Artemisia

Wormwood.

Abrotanum L. Europe

Absinthium L.

annua L. Asia

biennis Willd. N. W. U. S.

vulgaris L.

Erechtites

Fire-weed.

hieracifolia (L.) Raf.

Mesadenia

(*Cacalia*)

Indian Plantain.

atriplicifolia (L.) Raf. W. U. S.

reniformis (Muhl.) Raf.

Senecio

Groundsel.

obovatus Muhl.

Arctium

Burdock.

Lappa L. Europe

Carduus

(*Cnicus*)

Common or Plumed Thistle.

altissimus L.

arvensis (L.) Robs. Europe

discolor (Muhl.) Nutt.

lanceolatus L. Europe

Virginianus L.

Onopordon

Scotch Thistle.

acanthium L. Europe.

Adopogon
(*Krigia*)
DWARF DANDELION.
Carolinianum (Walt.) Britton
(*K. Virginica* Willd.)
Virginicum (L.) Kuntze
(*K. amplexicaulis* Nutt.

CICHORIACEAE

Tragopogon
SALSIFY.
porrifolius L. Europe

Taraxacum
DANDELION.
Taraxacum (L.) Karst. Europe
(*T. officinale* Weber)

Sonchus
SOW THISTLE.
arvensis L. Europe.
asper (L.) All. Europe
oleraceus L. Europe

Lactuca
LETTUCE.
Canadensis L.
sagittifolia Ell.
(*L. integrifolia* Bigel.
sativa C. Bauhin
GARDEN LETTUCE. Europe.
Scariola L. Europe.
spicata (Lam.) A. S. Hitchc.
(*L. leucophaea* A. Gray)
villosa Jacq.
(*L. acuminata* A. Gray)
virosa L.

Nabalus
(*Prenanthes*)
RATTLESNAKE-ROOT.
albus (L.) Hook.
altissimus (L.) Hook.
crepidineus (Michx.) DC.

Hieracium
HAWKWEED.
scabrum Michx.

Cichorium
Intybus L. Europe.

ARTICLE VII.—LIST OF MEDICINAL PLANTS, WILD OR CULTIVATED, GROWING IN THE VICINITY OF CINCINNATI, OHIO, WITH NOTES AS TO THE PARTS USED FOR MEDICINAL PURPOSES.

By Walter H. Aiken.

The numbers refer to the parts used, viz:
1, root; 1b, bark of root; 2, stem; 2b, bark; 2c, underground stem, 3, leaves; 4, flowers; 4b, buds; 5, fruit; 6, whole herb; 7, sap; 8, resinous exudations; 9, excrescences.

Osmunda regalis L.	1
" cinnamomea L.	1
Adiantum pedatum L.	6
Pteridium aquilinum (L.) Kuhn	6
Equisetum hyemale L.	6
Larix laricina (Du Roy) Koch.	2b
" Europaea L.	8
Thuja occidentalis L.	3
Juniperus Virginiana L.	3, 9
Typha latifolia L.	1
Alisma Plantago-aquatica L.	3
Avena sativa L.	5
Hordeum vulgare L.	5
Agropyrum repens (L.) Beauv.	1
Acorus calamus L.	2c
Spathyema foetida (L.) Raf.	1, 5
Arisaema triphyllum (L.) Torrey	2c
Allium Cepa L.	2c
" sativum C. Bauhin.	2c
Erythronium Americanum Ker.	1, 3
Asparagus officinalis L.	2
Vagnera racemosa (L.) Morong	1
Trillium erectum L.	1
" sessile L.	1
Dioscorea villosa L.	2c
Iris versicolor L.	2c
Corallorhiza odontorhiza Nutt.	1
" Wisteriana Conrad	1
Juglans cinerea L.	1b, 3
" nigra L.	5
Populus balsamifera candicans (Ait.) A. Gray	4b
Populus grandidentata Mx.	2b
" tremuloides Mx.	2b
Salix nigra Marsh	2b, 4
" purpurea L.	2b
Ostrya Virginiana Mx.	2b
Quercus alba L.	2b
" rubra L.	2b
" velutina Lam.	2b
Ulmus pubescens Walt.	2b
Morus rubra L.	2b, 5
Humulus Lupulus L.	4
Cannabis sativa L.	4, 8
Urtica dioica Pursh	1, 3
Adicea pumila (L.) Raf.	3
Asarum Canadense L.	1
" reflexum Bich	1
Aristolochia serpentarium L.	1
Rumex acetosella L.	3
" crispus L.	1
" obtusifolius L.	1

Polygonum erectum L........ 6
" punctatum L...... 6
Fagopyrum Fagopyrum (L.) Karst 5
Chenopodium ambrosioides L.. 5
" Botrys L........ 5
Amaranthus hybridus L....... 3
Phytolacca decandra L......1, 3, 5
Saponaria officinalis L........1, 3
Alsine media L................ 6
Nymphaea advena Sol......... 1
Castalia odorata (Dry.) W..... 1
Magnolia acuminata L........ 2b
Liriodendron tulipifera L..... 2b
Hydrastis Canadensis L........ 1
Actaea alba (L.) Mill.......... 2c
Cimicifuga racemosa (L.)..... 1
Syndesmon thalictroides L. Nutt....................... 1
Hepatica acuta (Pursh.) Br.... 6
Ranunculus repens L.........2c, 6
" sceleratus L.....2c, 6
Podophyllum peltatum L.....2c, 1
Jeffersonia diphylla (L.) Pers.. 1
Caulophyllum thalictroides L. 1
Berberis vulgaris L 2b, 5
Menispermum Canadense L.... 1
Sassafras Sassafras (L.) Karst. 1b
Benzoin Benzoin (L.) Coult..2b, 5
Sanguinaria Canadensis L..... 1
Chelidonium majus L..........1, 6
Papaver somniferum L........ 5
Bicuculla Canadensis (Gol.) Mill 1
Sisymbrium officinale (L.) Scop.......................5, 6
Roripa armoracia (L.) A. S. H.. 1
Bursa Bursa-pastoris (L.) Britt. 6
Heuchera Americana L........ 1
Hydrangea arborescens L...... 1
Liquidambar styraciflua L..... 7
Hamamelis Virginiana L.....2b, 3
Porteranthus stipulatus (Muhl) Brit...................... 1b
Rubus villosus Ait........... 1b
Fragaria Virginiana Duch..... 5
Potentilla Canadensis L........ 1
Geum Virginianum L.......... 1
Agrimonia mollis (T. & G.) Britt 1, 3
Malus Malus (L.) Britt........ 2b
Prunus serotina Ehrh......... 2b
Amygdalus Persica L.........3, 5
Cassia Marylandica L.......... 3
" Chamaecrista L 3
Gymnocladus dioicus L. (Koch.) 5
Baptisia tinctoria (L.) R. & Br..1, 3
Melilotus alba Desv...........3, 4
" officinalis (L.) Lam..3, 4
Trifolium pratense L.......... 4
Robinia Pseudacacia L.......2b, 3
Geranium maculatum L........ 1
Oxalis stricta L.............. 6
" violacea L 6
Linum usitatissimum L....... 5
Xanthoxylum Americanum L.2b, 5
Ptelea trifoliata L..... .... 1b
Ailanthus glandulosa Desf..1b, 2b
Polygala senega L 1
" viridescens L......... 1
Ricinus communis L..... 5
Euphorbia corollata Eng 1b
" maculata L......... 3
" Preslii Pursh....... 3
Callitriche Austini Eng........ 6
Rhus copallina L............2b, 5
" glabra L.... ....2b, 5
" hirta (L.) Sudw........2b, 5
" radicans L 3
Ilex opaca Ait................ 3
Euonymus atropurpureus Jacq. 1b
Celastrus scandens L.......... 1b
Aesculus Hippocastanum L.... 1b
Impatiens aurea Muhl......... 6
" biflora Wal......... 6
Ceanothus Americanus L..... 1b
Parthenocissus quinquefolia (L.) Pl..................2, 2b
Malva rotundifolia L......... 6

Viola odorata L. 6
Oenothera biennis (L.) Scop. 2, 2b
Aralia racemosa L. 1
Sanicula Marylandica L. 1
Washingtonia longistylis (Torr.) Britt. 1
Carum Carui L. 5
Daucus Carota L 1, 5
Cornus Amonum Mill 2b
" florida L 2b
Monotropa uniflora L. 1
Anagallis arvensis L. 3
Diospyros Virginiana L. 2b, 5
Fraxinus Americana L. 2b
" nigra Marsh. 2b
" quadrangulata Mx. . . 2b
Chionanthus Virginica L. 1b
Ligustrum vulgare L. 3
Sabbatia angularis (L.) Pursh. 6
Frasera Carolinensis Walt. 1
Apocynum androsaemifolium L. 1
" cannabinum L. 1
Asclepias incarnata L. 1
" Syriaca L. 1
" tuberosa L 1
Ipomoea pandurata (L.) Mey. . . 1
Polemonium reptans L. 1
Cynoglossum officinale L 1, 3
Lappula Virginiana (L.) Gr. . . 1
Mertensia Virginica (L.) D. C. 3
Verbena hastata L. 1
" urticifolia L 1
Scutellaria lateriflora L. 6
Marrubium vulgare L. 6
Nepeta cataria L. 3, 4
Glecoma hederacea L. 3
Leonurus Cardiaca L. 3, 4
Salvia lyrata L 3
" officinalis L. 3
Hedeoma pulegioides L. 6
Melissa officinalis L. 6
Koellia pilosa (Nutt.) Britt. . . . 6
" Virginiana (L.) McM. . . 6
Lycopus Virginicus L. 6

Mentha piperita L. 6
" spicata L. 6
Collinsonia Canadensis L. 6
Solanum Dulcamara L. 1, 2
" tuberosum L. 6
" nigrum L. 3
Lycopersicon Lycopersicon (L.) Karst. 6
Datura Stramonium L. 3, 5
Nicotiana Tabacum L. 3
Verbascum Thapsus L. 3, 4
Scrophularia Marylandica L. . . 1, 3
Chelone glabra L 3
Veronica peregrina L. 3
Leptandra Virginica (L.) Nutt. 1
Digitalis purpurea L. 3
Leptamnium Virginianum (L.) Raf 6
Catalpa Catalpa (L.) Karst. . . . 2b
Plantago Rugelii Dcne. 1, 4
Cephalanthus occidentalis L. . 2b
Galium Aparine L. 6
Sambucus Canadensis L. 4, 5
Viburnum opulus L. 2b
" prunifolium L. 1b
Lobelia inflata L. 3, 5
Vernonia fasciculata Mx 1
Eupatorium perfoliatum L. . . . 3, 4
" purpureum L. 1
Grindelia squarrosa (Pursh.) Dunal 3, 4
Aster puniceus L. 1
Erigeron ramosus (Wal.) B. S. P. 6
" Philadelphicus L 6
Anaphalis margaritacea L (B. & H.) 3
Inula Helenium L. 1
Polymnia Uvedalia L. 1
Silphium perfoliatum L. 1
Ambrosia artemisiaefolia L. . . . 3
" trifida L 3
Xanthium spinosum L. 6
Rudbeckia laciniata L. 6
Helianthus annuus L 5

Bidens bipinnata L. 1, 5
" connata Muhl. 1, 5
" frondosa L 1, 5
Helenium autumnale L. 6
Achillea Millefolium L. 6
Chrysanthemum Leucanthemum L. 3, 4
Chrysanthemum Parthenium (L.) Pers. 6
Tanacetum vulgare L. 6
Artemisia vulgaris L. 3, 4
Erechtites hieracifolia (L.) Raf. 1, 6
Arctium Lappa L. 1, 5
Cnicus arvensis (L.) Robs. 1
Taraxacum Taraxacum (L.) Karst 1
Lactuca sativa L 7
" virosa L. 7
Nabalus albus (L.) Hook. 6

ARTICLE VIII.—ORTHOGRAPHY OF NAMES OF THE NAIADES.

BY JOSUA LINDAHL (CINCINNATI).

The current literature on the fresh-water mussels, more than any other branch of zoölogy, is so filled with glaring orthographic blunders, that it seems necessary that something be done, without further delay, toward establishing a fixed basis for spelling the scientific names of the 1,200 species and varieties which, according to SIMPSON'S Synopsis*, belong to the world's fauna of the said group. More than one-fifth of them are now generally written wrong, in defiance of the rules for the orthography of such names. These rules are set down in a series of Canons and Recommendations in the *Code of Nomenclature*, adopted first by the American Ornithologists' Union (New York, 1892). The following have a particular bearing on the corrections which I am going to present.

> CANON VIII.—Proper names of species, and of subspecies or "varieties," are single words, simple or compound, preferably adjectival or genitival, or taken as such, when practicable agreeing in gender and number with any generic name with which they are associated in binominal or trinominal nomenclature, and written with a small initial letter.

> CANON XXX.—Specific names when adopted as generic are not to be changed.

> CANON XL.—The original typography of a name is to be rigidly preserved, unless a typographical error is evident.

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*Synopsis of the Naiades, or Pearly Fresh-Water Mussels. By Charles Torrey Simpson, Aid, Division of Mollusks. From the Proceedings of the United States National Museum, Vol. XXII, Washington, 1900.

Remarks.— . . . . restrict the emendation of names to the correction of obvious or known typographical errors involving obscurity.*

RECOMMENDATION I.—The rules of Latin orthography are to be adhered to in the construction of scientific names.

Remarks . . . . For instance, the names which modern authors have written *Aipunemia* . . . *poiocephala*, must, according to the laws of etymology, be spelt *Æpycnemia* . . , *pœocephala*.

Simpson gave four different forms to the name of one of the new genera, described in his "Synopsis," viz.: *Schistodesmo* (pp. 506 and 514). *Shistodesmus* (pp. 803 and 804), *Shistodesma* (p. 1036), and *Schistodesmus* (Table of Contents, p. vi of the separate edition of the Synopsis, while the Table of Contents of the whole volume of Proceedings has, on p. vii, *Shistodesmus*). The spelling of the first syllable as "*Shi*" is an impossibility in a Greek word, and the above Recommendation I demands that it be written "*Schi.*" MR. BRYANT WALKER (in letters) urges, correctly, that the forms used previous to page 803, where the species is first defined, shall be considered as *nomina nuda*. The name, properly transliterated, must therefore stand as *Schistodesmus*.

RECOMMENDATION II.—In latinizing personal names only the termination should be changed, except as in cases provided for under Recommendation IV.

Remarks.— . . . . . . This recommendation . . . . , is particularly to be observed in many names ending in *a*, the genitive of which should be *æ*.

RECOMMENDATION IV.—Names adopted from languages . . . . . containing characters not represented

*Such an *error involving obscurity*, albeit the fault of the author rather than of the typographer, we find in the name of *Quadrula keineriana*, dedicated by Lea to: "Mr. L. C. Keiner, the author of *Iconographie des Coquilles Vivantes*." But that author's name was L. C. KIENER. A similar error occurs in Lea's *Anodonta jewittiana*, named in honor of Col. E. Jewett.—Would anybody hesitate to correct such *lapsus pennæ*?—See the following Recommendation II.

in the Roman alphabet . . . . should be rendered by the corresponding Roman letters or combinations of letters.

Remarks.—The German *ö* . . . may be rendered . . . by . . *œ*.

The above canons and recommendations may be supplemented by the following rule, for certain cases not considered by the authors of the Code:

SUPPLEMENTARY RULE.—When the gender of a word used as a generic name can not be decided by any etymological rule, *priority of use* shall settle the question.

Remarks.—There are two generic names, *Lampsilis* and *Glabaris*, to which no linguistic rules can be applied for determining their gender, except so far that neither of them can be a neuter. Nor is there any rule in the A. O. U. Code by which it can be decided whether they are to be considered as masculines or feminines. But Rafinesque, who invented the name *Lampsilis*,* described under that new genus three species, one of which, *L. ovata*, shows that he meant it to be a feminine. William Stimpson, in his "Shells of New England," used it likewise as feminine, and the various later authors who have treated it as a masculine are in error.

J. E. Gray coined the name *Glabaris* without ever using it coupled to any specific name. The first author who used it in such combinations was Von Ihering. In his "Najaden von S. Paulo," 1893, he referred half a score of species to that genus using the name as feminine, and this priority of use must be accepted as decisive.

Professor Walter Miller, now of the Tulane University in New Orleans, published, some years ago, a most excellent güide for the compounding of names from Latin and Greek roots,† which ought to be carefully perused by Zoölogists and

*Monographie des Coquilles Bivalves Fluviatiles de la Rivière Ohio. Bruxelles, 1820.

†Scientific names of Latin and Greek Derivation.—Proc. Cal. Ac. Sc., Third Ser, Zoology, Vol. I., No. 3.—San Francisco, 1897.

Botanists. He says (p. 127): "If the final member of a nomen compositum is a noun, the compound will have the form and gender and inflectional stem of that noun," and further (p. 129): "The gender of the genus name, when it is made a noun, depends not on the termination, but upon the gender of the noun forming the final element of the compound."

This rule is, however, not easily applied in cases where the compound has been so distorted, that it is hard to tell whether to consider the word as a genuine noun or some kind of malformed adjective made to pose as a noun. Such examples may be found in *Anodonta*, *Alasmidonta*, *Symphynota* and *Mycetopoda*. To treat them as masculines because the final elements of each of them is a masculine noun, it would be futile to attempt. We must leave them as feminines. But the rule is fully applicable to all names terminating in *opsis*, which must be feminines (ἡ ὄψις) and those in *bema*, *desma*, *branchus* and *rhynchus*, all of which are neuter—τό βῆμα, τό δέσμα a band, (not from ἡ δέσμη, a bundle), τά βράγχια, gills, (not from ὁ βράγχος, hoarseness), and τό ῥύγχος.

Many of our conchologists have been puzzled how to handle specific names with such terminations as we find in adjectives, and the mistaken idea that all specific names are to be considered as adjectives has led them occasionally to inflect these nouns as adjectives. *Unio clava* has often been written *U. clavus*, whereby the intention of the original author to compare its shape to that of a *club* was perverted so as to make it look like a *nail*. The name *Unio calceolus*, suggesting the resemblance of the shell to a slipper, was changed to *Margarita calceola*, which suggests nothing at all. While such inflections are obviously wrong, it might appear reasonable, when the noun denotes a living being and the Latin language has two forms for resp., male and female individuals, that the form should be used which corresponds to the gender of the generic name. *Unio corvunculus* may thus become *Lampsilis corvuncula*. But a consistent application of such a rule may lead to a perversion of the significance of the original name. For example: the European stag-beetle (*Lucanus*

cervus) has its name from the striking resemblance of its mandibles to the antlers of a stag (*cervus*). If that species should have to be transferred to another genus, *F.*, which happens to be a feminine noun, and we call the said stag-beetle *F. cerva*, the fitness of the original appellation would be sadly destroyed, as the doe (*cerva*) has no antlers. The only safe rule for the orthography of a specific name, when the species shall be shifted from one genus to another, is therefore : *leave all nouns unaffected by the gender of the generic name.*

In many specific names ending on *ensis*, after a geographical name ending with a vowel, that vowel is elided, while in others it is not, and, in some of the latter, *ae* is written as a diphthong, in others as two distinct vowels. Professor Miller, whom I have consulted on this question, writes me: "Before the suffix *ensis*, elision is *imperative*, except in the case of *y*, which is so often a consonant that it is always so treated. The words suggested would accordingly appear as *bhamensis*, *chalcensis*, *cincinnatensis*, *demerarensis*, *monroensis*, *ohiensis*, *tampicensis*, *omensis*, *topekensis*, *ujijensis*, *tavoyensis*, *etc.*"

In the following list of corrected names I have used Simpson's Synopsis as the basis. The rest of the names adopted, or given, by Simpson may be considered as unassailable under the protection of the code. Fully aware of the danger of doing mischief by any unnecessary change of a published name, I have submitted proofs of this paper to five eminent judges on questions of nomenclature, and, in every instance, I have abided by the verdict of the majority of them—even in the case of *Dromus dromas*, which, according to Canon XXX, certainly ought to be *Dromas dromas*. I beg herewith to express my sincere gratitude for the help thus rendered by Drs. Wm. Dall, Theodore Gill, Leonhard Stejneger and Victor Sterki and Mr. Bryant Walker.

List of Corrected Names.

Lampsilis (fem.).
ventricosa,
" satura,
excavata,
binominata,
cariosa,
ovata,
ochracea,
splendida,
perpasta,
clarkiana,
multiradiata,
brevicula,
" brittsi,
biangulata,
luteola,
" rosacea,
radiata,
" conspicua,
hydiana,
approxima,
contraria,
porphyrea,
straminea,
reeviana,
ligamentina,
" gibba,
orbiculata,
tæniata,
picta,
punctata,
bracteata,
venusta,
fallaciosa,
recta,
nasuta,
subrostrata,
lienosa,
" unicostata,
propria,
punicea,
obscura,
vaughaniana,
constricta,
apicina,
nigerrima,
fatua,
planicostata,
nebulosa,
muehlfeldiana,
amœna,
tenera,
sima,
planca,
subangulata,
kirklandiana,
perpurpurea,
vibex nigrina,
suda,
villosa,
pellucida,
papyracea,
singleyana,
texasensis compressa,
parva,
haliana,
germana,
mæsta,
paula,
pulla,
alata,
" poulsoni,

rovirosæ,
purpurata,
umbrosa,
tampicensis,
livida,
explicata,
alienigena,
metallica,
lævissima,
amphichæna,
scutulata,
paludosa,
argyrata.

Hyriopsis (fem.).
bialata,
myersiana,
pinchoniana,
vagula,
caudiculata.

Lepidodesma (neu.).
aliger.

Nephronaias (fem.).
medellina,
reticulata
scamnata,
æruginosa,
rugulosa,
persulcata,
plicatula,
ravistella,
vellicata,
mellea.

Ptychobranchus (neu.).
clintonense,
foremanianum,
trinacrium.

Dromus (mas.).
dromas,

Anodonta (fem.).
wahlamatensis,
luculenta.
aurea,
curvata,
picta,

Gabillotia (fem.).
euphratica churchilliana.

Unio (mas.).
platyrhynchoideus,
congareus.

Alasmidonta (fem.).
calceolus

Pleurobema (neu.).
maculatum,
holstonense,
bournianum,
edgarianum,
ravenelianum,
oviforme,
ornatum,
appressum,
validum,
swordianum,
subglobatum,
crudum,
barnesianum,
pudicum,
bigbyense,
decisum,
chattanoogense,
interventum,

murrayense.
curtum,
taitianum,
perovatum,
stabile,
troschelianum,
irrasum,
altum,
hartmanianum,
instructum,
verum,
rubellum,
furvum,
hanleyanum,
flavidulum,
bulbosum,
reclusum,
brumbyanum,
strodianum,
patsaligense,
favosum,
lenticulare,
litum,
georgianum,
pyriforme,
modicum,
striatum,
gibberum,
fascinans rhomboideum,
argenteum,
" pannosum,
connasaugense,
breve,
" subellipticum,
planius,
estabrookianum,
striatulum,
amabile,
cicatricosum.

Quadrula (fem.).

aspera,
pustulosa kieneriana,
coccinea paupercula,
polysticto-scripta,
polysticta,
microsticta,
triclavus,
cornuum-lunæ cinnamomea.

Schistodesmus (mas.).

Cuneopsis (fem.).

capitata.

Nodularia (fem.).

soboles,
æquatoria,
caffra,
" africana,
" vaalensis,
hygapana.

Pseudodon (mas.).

ellipticus,
cambodiensis.

Parreysia (fem.).

wynegungensis,
vulcanus,
burmana,
gowhattensis,
ngesiana,
hypsiprymnus,
chinensis squamosa.

Ptychorhynchus (neu.).

pfisteri inspiratum,

mediastinum,
apicellatum,
schomburgkianum,
murinum (see Errata, Synopsis, p. viii)

Ctenodesma (neu.).
borneense.

Tetraplodon (mas.).
quadrilaterus.

Castalina (fem.).
psammœca.

Diplodon (mas.).
rhyacœcus,
wagnerianus,
æthiops piricicabanus,
demerarensis,
hylæus.

Spatha (fem.).
wahlbergi bourguignati.

Monocondylæa (fem.).
inermis.

Glabaris (fem.).
patagonica.
" felix,
crassa,
rubicunda,
rotunda,
membranacea,
crispata,
philippiana,
luteola,
schomburgkiana,
cylindracea,
puelchana,
limnœca,
lucida,
trautwiniana,
trapezialis,
" anserina,
" exotica,
" scripta,
" moretoniana,
" cygnæiformis.
radiata,
simpsoniana,
sinuosa,
glauca,
" sinaloensis,
umbonata,
jewettiana,
forbesiana,
trigona,
elongata,
lingulata,
mortoniana,
longina,
leotaudi,
tenebricosa,
pastasana,
schrœteriana,
obtusa,
liturata,
falsa.

ARTICLE IX.—PISOLITIC BARITE.

By Herman Wuestner,

Curator of Minerals, Cincinnati Society of Natural History, Cincinnati.

Mr. B. P. Thrasher, residing at present at Saratoga, Texas, on October 24th last, sent to the Museum of the Cincinnati Society of Natural History, a few pellets of a mineral labeled as follows: "*From water strata, 1350 feet below surface, at Saratoga, Hardin Co., Texas. Several barrels of them blown out by gas in boring for oil.*"

The specimens being turned over to me for examination, blowpipe analysis soon proved these pellets to consist of barite, a mineral which has never hitherto been recorded as occurring in pisolitic form.

Dr. Josua Lindahl, Director of the Museum, wrote at once to Mr. Thrasher, asking him to send more abundant material for examination. In response, Mr. Thrasher forwarded about four ounces of the same material, declaring this was all that remained, all the rest of it having been left on the ground, whence it had now been washed away beyond recovery. He also supplemented his previous statements by giving the temperature of the water that brought up the pellets as 120° F. (about 49° C.), adding that this was the only instance where such material had been obtained at any oil boring in that region.

Among the pellets were found a few fragments of a brown fossil of a porous, sponge-like structure and saturated with petroleum. These, too, proved to consist mainly of barite. One of them was sent to Dr. E. O. Ulrich, of the U. S. Geological Survey, Washington, D. C., for possible indentification. Dr. Ulrich, kindly replying, states that the specimen is "a fragment of one of the reef building corals," and that

"the occurrence of such corals in the Miocene of Texas is well known." He had further consulted his colleague, DR. T. W. VAUGHAN, who said that it "may be an Acroporid coral, but too poorly preserved for definite determination" Fig. 1 shows photograph of one of these fragments, enlarged 8 diam.

FIG. 1.

The pellets in a subsequent chemical analysis (see below) were shown also to contain calcium sulfate and strontium sulfate in weighable quantities. They have evidently been formed around fragments of the coral as a nucleus, investing such fragments with concentric layers of barium (calcium and strontium) sulfate.

Dr. Ulrich, in his communication, suggests that "the sulfate of barium covering may be a metasomatic replacement of a similar original calcium carbonate investment. Such a replacement may, as in this case, extend to and include the nucleus."

As to the structure of the pellets, a transverse section reveals tubes radiating from the nucleus like spokes of a wheel (see Figs. 2–4), imbedded in a series of two or three incrusting concentric shells, surrounded by a series of cortical layers, into which the radiating tubes do not extend, though some radiated structure is discernible in the microscopic section of these cortical layers also. It seems that after the deposition of the inner shells, the process was interrupted, and the outer shells were formed at a later period.

The inner layers are of a bluish white tint and quite compact; the cortical layers are creamy white and of less compact

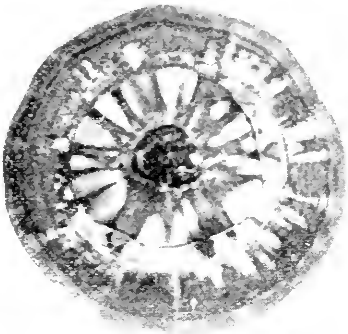

FIG. 2.

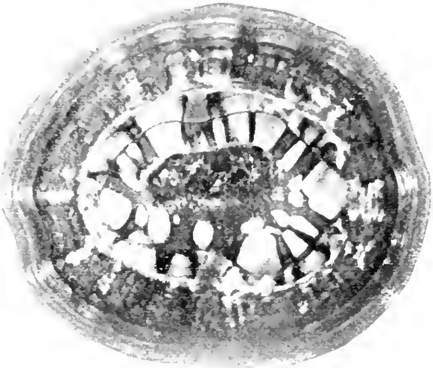

FIG. 3.

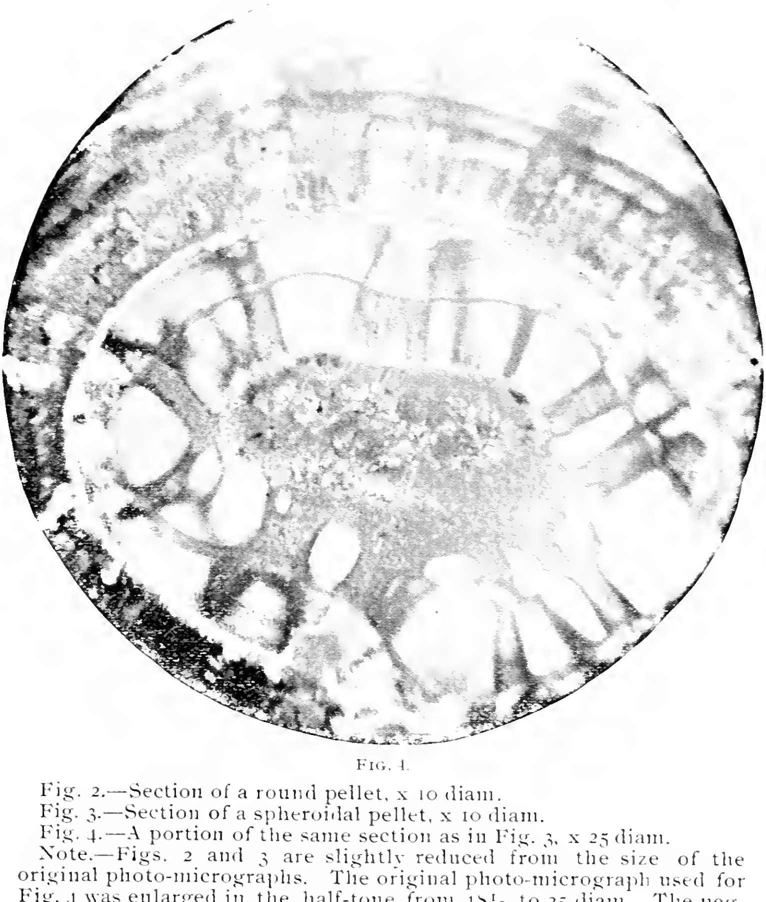

FIG. 4.

Fig. 2.—Section of a round pellet, x 10 diam.
Fig. 3.—Section of a spheroidal pellet, x 10 diam.
Fig. 4.—A portion of the same section as in Fig. 3, x 25 diam.
Note.—Figs. 2 and 3 are slightly reduced from the size of the original photo-micrographs. The original photo-micrograph used for Fig. 4 was enlarged in the half-tone from 18½ to 25 diam. The negative was taken under Obj. 1, Oc. 1 (Winckel).

structure. When a transverse section of a pellet is immersed for a moment in carmine ink and then washed in water, the cortical layers will be seen to have readily absorbed the ink, while the inner layers are not affected by the staining fluid. Still, upon crushing, even the cortical layers present a considerable degree of hardness.

The pellets are of a strikingly uniform appearance. With the exception of the smallest ones, on which the incrustation has just commenced, and which therefore still present the irregular form of the nucleus, they are in most cases nearly spherical, rarely spheroidal or discoidal.

About one-third, in bulk, of the whole quantity consists of broken pellets, the remaining two-thirds being unbroken, and the total number of these is 456, varying in size, weight and form as follows:

25 pellets, diameter 2.0 to 4.0 mm, form irregular nodular; cortical layer thin, or none; ends of tubuli often plainly marked on the surface, but rarely with an open lumen. Weight of the smallest specimen .09 gm.

37 pellets, diameter 4.0 to 4.5 mm, form approximately spherical. Average weight .22 gm.

384 pellets, diameter 4.5 to 5.0 mm, nearly spherical. Average weight .24 gm.

10 pellets, diameter more than 5 mm in one direction, not over 4.5 mm in another direction. These 10 specimens are either prolate or oblate spheroidal in shape. The largest one, an oblate spheroid, having diameters of 4 and 7.5 mm, weighs .40 gm.

The largest fragment of the coral (Fig. 1) measures 8 mm. in width, but only 3 mm in thickness, and weighs .13 gm; another, 6 mm. in width, has a thickness of 3.5 mm. The others a still smaller.

In order to account for the uniformity of the round pellets and the scarcity of the flat ones, we may suppose that, in tapping the underground repository of these peculiar formations, the upward stream of water carried only those pellets which did not exceed a certain maximum weight. As to the flat pieces, whose weight exceeds that limit, it seems that the

stream brought to the surface only those few which happened to present their flat surface in a direction perpendicular to that of the upward pressure. The others, tilted, did not present as large an *effective* surface, i. e., did not sustain the same lifting force.

The manner in which these pellets were formed is probably a matter of conjecture. In this particular case, it is not likely that these bodies were carried by a subterranean stream, because, as Mr. Thrasher states, no such material has been encountered before in deep borings which have been carried on in neighboring localities.

It is quite probable, therefore, that the pellets are the product of a confined locality, and were formed by a subterranean spring carrying barite in solution, much in the same manner as the pisolitic aragonite in the Sprudel of Carlsbad, Bohemia, is believed to be formed. The coral fragments resulting from the breaking up of an underground deposit, were carried up by the spring, and each fragment was kept spinning around while layer after layer of barite was deposited around it, a process which continued until the pellets grew too heavy to be kept in suspension.

The radiating tubuli may then be the result of the centrifugal force by which the oil contents of the nucleus were constantly brought to the open pores on the surface, preventing deposition of barite within the pores. Each additional coating encroached, however, on the lumen of each tubule, causing them to grow narrower as their length increased.

Whether the coral nucleus and the incrusting shells, originally, consisted of barite, or of calcite subsequently changed by a metasomatic substitution of barite, is a question which it may not be possible to decide as long as the original deposit of the material remains inaccessible. A similar substitution has taken place in the oolite from Centre County, Pa., where silica has taken the place of calcium carbonate.

Dr. S. Waldbott, of the Ohio Mechanics Institute, has most kindly made a quantitative analysis of the materials herein described, and submits the following results:

	Shell .8461	Nucleus .4084	Coral .0617
Volatile Hydrocarbons.........	.77%	.98%	1.62%
Volatile at red heat............	.23	.20	3.08
Ba SO_4	92.73	92.59	83.4
Ca SO_4	3.31	2.79	undetermined
Sr SO_4	1.36	1.04	none
Undetermined (iron, unburned carbon)..................	1.60	2.40	
	100.00%	100.00%	

*After removing nuclei from several broken pellets.
†Taken out of the same broken pellets.

Specific gravity of pellets, 3.99.

In order to ascertain the geological age of the stratum whence the pellets were ejected, Dr. Lindahl secured, through the courtesy of Mr. Thrasher, a copy of the boring log, which contained the following note: "1322 to 1375 feet: Oil, sand, ... Formations (pellets) came from 1350 feet. Water temperature 120°."

Comparing the log with data published in U. S. G. S., Bulletin No. 212 ("Oil Fields of the Texas-Louisana Gulf Coastal Plain. By Dr. C. W. Hayes and William Kennedy), Dr. Lindahl came to the conclusion that the strata at the above depth might reasonably be guessed to belong to the lowest Neocene beds, "3 d" of the section on page 20 of the said Bulletin, and Dr. Hayes, to whom the log was submitted, confirmed the conjecture in the following words: "This is as near as any one else could guess.—C. W. H." The Bulletin states that sands of those beds "carry fossils of Miocene age." As remarked above, Drs. Ulrich and Vaughan considered the brown particles as fragments of a Miocene coral.

For the photo-micrographs, here reproduced in half-tone (Figs. 2–4), I am greatly indebted to Drs. M. L. Heidingsfeld and A. J. Markley, of Cincinnati. I also wish to express my gratitude to Dr. Josua Lindahl, Director of the Museum of the Cincinnati Society of Natural History, for his kind and unselfish co-operation in connection with the subject herein presented.

ARTICLE X.—ECOLOGICAL NOTES ON SOME COLEOPTERA OF THE CINCINNATI REGION, INCLUDING SEVEN NEW SPECIES.

By Charles Dury (Cincinnati).

Hamotus batrisioides *Lec.*

I have taken a number of this curious species by sifting the decayed and honeycombed interior of a standing dead tree. Both males and females were taken. I notice that the antennal club of female is smaller than that of the male. April 2 to May 2, Cincinnati, Ohio.

Homœusa expansa *Lec.*

This flat little species was sifted from a nest of pale ants, *Lasius claviger*, May 7.

Scopæopsis duryi *Casey.*

Sifted from the debris of a patch of withered fungus, *Agaricinæ*; three specimens. See Revision of American Pæderini. Casey. Trans. St. Louis Acad. 1905, vol. xv., No. 2, p. 216.

Ptinidium lineatum *Lec.*

This very minute species lives under the decaying bark of the "Honey Locust," in moist places. I have also sifted it from the debris at the base of these trees. May 4.

Anamorphus pusillus *Zimm.*

One specimen, July 7, taken feeding on fungus on beech log in company with *Rymbus minor*, which species it resembles in an astonishing manner.

Colyphus melanopterus **n. sp.**

Jet black, shining, except the thorax, which is rose pink, and the mouth and front, which are pale testaceous. Head

with scattered, fine punctures. Front with a broad crescentic impression, interrupted at middle. Eyes large, prominent. Antennæ eleven-jointed, without club, the joints gradually becoming wider to the tenth. Thorax with a broad black furcate mark extending from base to apex. Elytra coarsely cribrate and but little wider than thorax; widest about the middle, with prominent humeri. Body sparsely covered with erect black hairs. This species comes nearest *Colyphus furcatus* Sch., but is longer, much less hairy, the elytra are more shining and immaculate jet black. 8 mm. Cincinnati, Ohio. As defined by Mr. Gorham in Biologia, vol. iii., p. 2, this species belongs in his "Sec. A." I took one specimen while sweeping low vegetation in river bottom, July 5, 1905. I was very much surprised to see a representative of this genus so far north as Cincinnati.

PTILINUS RUFICORNIS *Say.*

May 20, 1905, I saw a maple stump that had a large flat sliver sticking up on one side. Into this a number of this species were cutting round holes. Many of them were half buried, leaving the posterior end sticking out of the hole. All were females. Until late in June they were at work here, and also on the wood of a split beech tree. I never take males in such a situation, but get them by beating dead branches. The male is much rarer than the female.

ODONTOSPHINDUS DENTICOLLIS *Lec.*

June 11, 1905, I took this species eating a dark brown powdery fungus that was growing on a poplar log. *Sphindus americanus* Lec lives in same fungus. *Americanus* is abundant, *denticollis* is rare, and *Eurysphindus hirtus* Lec. is very rare here.

LACHNOSTERNA VEHEMENS *Horn.*

Twenty-two males of this species were taken flying about electric lights. Superficially it resembles *L. fusca* very closely, but the curved and hooked inner spur of hind tibia and the broad angulation of hind femur distinguish it. The types

were from Kansas. It is a very abundant species here, but no females have yet been taken.

CRIOCERIS ASPARAGI *Linn.*

The first specimen I have seen from Cincinnati of this introduced species was taken July 7, 1905, on Walnut Hills, by Miss Anette Braun.

NEOBROTICA (GALERUCA) DORSATA *Say.*

In a note by me in Ent. News for February, 1904, p. 53, I mention the occurrence of this beautiful Chrysomelid. Further search shows the thing to be abundant, and that its plant is perhaps the "Spiderwort" *Tradescantia Virginica*. I failed to find the larvæ, but the stems of the plant were, many of them, eaten out by some large larvæ. I could not find any evidence that they had eaten the roots, as does *Diabrotica* on other plants. Wherever I found the "Spiderwort," there I found the beetles. In a large patch of the plant, as late as July 22, 1905, I found them common, though very wild. I netted forty-three; all were females, the males being entirely gone at this date. The curiously modified male antennæ suggest that the species is a *Neobrotica*.

EPITRIX HUMERALIS **n. sp.**

About the size and proportions of *Epitrix fuscula* Crotch, but with coarser punctures on elytra. Ante-basal impression well marked. Color rufous with a feebly defined piceous cloud on disk of elytra. The humeral umbones with a pale spot, not sharply defined. Legs rufotestaceous. Length 2.5 mm. Three specimens from Cincinnati, O., one from Indiana and one from Kansas (Mr. Knaus).

CREPIDODERA ÆSCULI **n. sp.**

Allied to *Crepidodera rufipes*, but averages more slender, color of adult (including thorax) always dark piceous green, shining. Legs pale as in *rufipes*. Immature specimens paler, but always showing the green reflections. Thorax more distinctly punctured than rufipes. Length 3.5 mm. Occurs

abundantly on the "Buckeye," *Æsculus glabra*. *Crepidodera rufipes* occurs on the common locust *Robinia pseudacacia*.

PHYLLOTRETA LINDAHLI **n. sp.**

Elongate oval, convex, black, shining. Thorax wider than long, minutely alutaceus. Punctures fine, becoming coarser towards base. Elytra, wider at base than thorax, with humeri rounded. Disk coarsely punctured, with a faint strial arrangement. Tibia, tarsi and antennæ (except the last four joints of antennæ, which are piceous) pale.

Male characters.

Last ventral segment rounded at tip with a deep rounded depression, which extends forward in triangular shape through the entire length of the penultimate segment. In bottom of the depression is a groove extending its length. There are two minute tubercles at bottom of depression near apex of last segment.

Female characters.

Last ventral segment with a shallow fovea near tip. Obliterated in one specimen.

Four specimens 2.5 mm. Cincinnati, Ohio, May 30. This species belongs in series "B." *Phyllotreta* of Horn's paper on Halticini, Trans. Amer. Ent. Soc. xvi, and comes nearest *lewisii*. Dedicated to that industrious naturalist, Dr. Josua Lindahl.

EUSTROPHUS BRUNNEIMARGINATUS **n. sp.**

Oval, convex, moderately attenuate posteriorly. Body above black, sparsely pubescent. Head rufous, coarsely punctured. Eyes very narrowly separated. Thorax finely punctured, and with a broad brown marginal band, extending around the front from one hind angle to the other. This band is rather densely pubescent with fulvous hairs. Elytra striato-punctate, with a similar brown band extending around margin from one humerus to the other. Beneath, including legs, rufous, rather finely punctured. The punctures of mesosternum and ventral segments being ocarser than those of pro-

notum. The sculpture is rather coarser than in *Eustrophus bicolor*. Prosternum is not prolonged behind coxæ. Posterior tibiæ have transverse ridges, as in *E. bicolor*. As compared with *bicolor* this species is smaller, broader for its length, less shining, much less attenuate behind, less distinctly striate, with finer punctures in striæ, and with the fulvous border. Antennæ as in bicolor. Two specimens, Kentucky, near Cincinnati, Ohio, 4.8 mm. and 3.7 mm. long.

MORDELLISTENA DELICATULA **n. sp.**

Elongate, very slender, piceous in color, with front of head, mouth parts, front and middle legs and antennæ pale rufotestaceous. The elytra thickly covered with rather coarse, sage green pubescence. Tibia with two ridges, anterior one extending across the outer face of the tibia. First tarsal joint with three, second with two oblique ridges. Length 3.3 mm. Seven specimens, Cincinnati, Ohio. The most slender species I have seen. The bright shining sage green pubescence fades out to silvery in old specimens. From the description I had always thought this was *splendens* Smith. But after seeing some of that species collected at Cameron, La., by Prof. Hine, and, comparing with the types in national museum, I see it is quite different.

ACROSCHISMUS

Acroschismus is a generic name proposed by Mr. W. D. Pierce for some new species of the family *Stylopidæ*, specimens of which I have bred here from parasitized wasps. I have taken three distinct species, for which Mr. Pierce proposes the names in following list (Art. XI.). Descriptions will be given in a monographic paper shortly to be issued by him.

CATASPASTUS CONSPERSUS *Lec.*

Occurred by hundreds on "Prickly Ash" (*Xanthoxylum*) May 5.

CANISTES SCHUSTERI *Csy.*

I took two of this very rare species July 12, 1905. They were standing high up on their clumsy legs in a patch of dark

colored fungus which was growing on the underside of a beech log in thick woods. They were gnawing at the fungus.

IDIOSTETHUS SUBCALVUS *Lec.*

Occurs in great numbers in the flowers of *Hydrophyllum appendiculatum.* May. I have been unable to find its larvæ.

PSOMUS POLITUS *Csy.*

Occurs commonly on ash sprouts (*Fraxinus americana*) June 1 to 25.

ARTICLE XI.—ADDITIONS TO THE LIST OF CINCINNATI COLEOPTERA.

BY CHARLES DURY.

In Article V. of this volume* I have enumerated 2,031 species of Coleoptera observed near Cincinnati. In the following Supplementary List 209 species are given, making a total of 2,240 species. I have yet more than fifty unidentified species. I think 2,500 or more species will eventually be found here.

CICINDELIDÆ.

Cicindela duodecimguttata *Dej.*

CARABIDÆ.

Cychrus nitidicollis *Chev.*
Scarites substriatus *Hald.*
Dyschirius globulosus *Say.*
Aspidoglossa subangulata *Chd.*
Bembidium guexi *Chd.*
 postfasciatum *Ham.*
 dentellum *Thunb.*
 dilatatum *Lec.*
Tachys corruscus *Lec.*
Pterostichus purpuratus *Lec.*
Stolonis ulkei *Horn.*
Badister flavipes *Lec.*
Apristus subsulcatus *Dej.*
Chlænius laticollis *Say.*
 solitarius *Say.*
Gynandropus hylacis *Say.*
Selenophorus pedicularis *Dej.*
Harpalus autumnalis *Say.*
Acupalpus carus *Lec.*

SILPHIDÆ.

Aglyptus lævis *Lec.*

HYDROPHILIDÆ.

Cercyon navicularis *Zimm.*
 flavipes *Fab.*
 analis *Payk.*

SCYDMÆNIDÆ.

Eutheia americana *Casey.*

PSELAPHIDÆ.

Hamotus batrisioides *Lec.*
Decarthron abnorme *Lec.*
 exsectum *Brend.*
Batrisus virginiæ *Casey.*
Euplectus congener *Casey.*

STAPHYLINIDÆ.

Falagria quadriceps *Lec.*
Xenodusa cava *Lec.*
Homœusa expansa *Lec.*
Oxypoda opacula *Fauv.*
Myllæna infuscata *Kraatz.*
Bolitochara picta *Fauv.*
Heterothops pusio *Lec.*
Philonthus asper *Horn.*
 quadricollis *Horn.*
 microphthalmus *Horn.*
 sordidus *Grav.*
 inquietus *Erich.*
 serpentinus *Horn.*
 micans *Grav.*
Xantholinus gularis *Lec.*

* "A revised list of Coleoptera observed near Cincinnati, O."—This Journal. Vol. XX, No. 3, Art. V.

Lathrobium pallidulum *Lec.*
Leptolinus rubripennis *Lec.*
Gastrolobium carolinum *Er.*
Hesperobium sellatum *Lec.*
cribratum *Lec.*
Scopæopsis duryi *Casey.*
Stilicus opaculus *Lec.*
Sciocharella n. sp.
near delicatula
Sciocharis carolinenis *Csy.*
Leptogenius brevicornis *Csy.*
Sunius brevipennis *Auct.*
prolixus *Er.*
discopunctatus *Say.*
Tachinus nitiduloides *Horn.*
repandus *Horn.*
fimbriatus *Grav.*
Tachyporus nanus *Er.*
elegans *Horn.*
Conosoma knoxii *Lec.*
pubescens *Payk.*
Boletobius axilaris *Grav.*
quæsitor *Horn.*
Mycetoporus lucidulus *Lec.*
lepidus *Er.*
Oxytelus exiguus *Er.*
Lispinus linearis *Er.*
Nototaphra lauta *Casey.*
Atheta (near sordida *Melsh.*)
Anthobium convexum *Fauv.*
Eleusis canadensis.

TRICHOPTERYGIDÆ.

Ptinidium evanescens *Marsh.*
lineatum *Lec.*
Ptinellodes lecontei *Matth.*

SCAPHIDIIDÆ.

Bæocera apicalis *Lec.*
abdominalis *Csy.*

PHALACRIDÆ.

Severalunidentified species

CORYLOPHIDÆ.

Sacium misellum *Lec.*
Corylophodes marginicollis *Lec.*
Orthoperus micros *Casey.*

COCCINELLIDÆ.

Hyperaspis punctatus *Melsh.*

ENDOMYCHIDÆ.

Symbiotes pygmæus *Gohr.*
sp.
Anamorphus pusillus *Zimm.*

EROTYLIDÆ.

Languria uhleri *Horn.*
Acropteroxys lecontei *Cr.*

COLYDIIDÆ.

Synchita laticollis *Lec.*

CRYPTOPHAGIDÆ.

Henoticus serratus *Gyll.*
Cryptophagus acutangulus *Gyll.*
n. sp.
Cænoscelis obscura *Casey.*

MYCETOPHAGIDÆ.

Mycetophagus subdepressus *Csy.*

DERMESTIDÆ.

Cryptorhopalum triste *Lec.*

NITIDULIDÆ.

Brachypterus urticæ *Fab.*
Cercus pennatus *Murr.*
Carpophilus melanopterus *Er.*
Epuræa planulata *Er.*

LATHRIDIIDÆ.

Holoparamecus caularum *Aubé.*
Corticaria ferruginea *Marsh.*
elongata *Gyll.*
Cartodere costulata *Reit.*
Melanophthalma longipennis *Lec.*

DASCYLLIDÆ.

Eucinetus strigosus *Lec.*

ELATERIDÆ.

Microrrhagus imperfectus *Lec.*

Adelothyreus dejeani *Bonv.*
Nematodes collaris *Bonv.*
Hylochares nigricornis *Say.*
Esthesopus claricollis *Say.*
Cryptohypnus choris *Say.*
melsheimeri *Horn.*
cucullatus *Horn.*
Hypnoides striatulus *Horn.*
Elater collaris *Say.*
pusio *Germ.*
insignis *Lec.*
Drasterius amabilis *Lec.*
Agriotes insanus *Cand.*
Dolopius lateralis *Esch.*
Limonius plebejus *Say.*
n. sp.
Athous cucullatus *Esch.*
Corymbites signaticollis *Melsh.*

THROSCIDÆ.

Alonothroscus calocerus *Bon.*

BUPRESTIDÆ.

Anthaxia flavimana *Gory.*
Agrilus n. sp.

MALACHIDÆ.

Pseudebæus apicalis *Say.*
Attalus melanopterus *Er.*

CLERIDÆ.

Hydnocera difficilis *Lec.*
Chariessa onusta *Say.*
Colyphus melanopterus *Dury.*

PTINIDÆ.

Ptinus falli *Pic.*
Oligomerus obtusus *Lec.*
Trichodesma klagesi *Fall.*
Hadrobregmus pusillus *Fall.*
Xyletinus harrisi *Fall.*
Lasioderma semirufum *Fall.*
Petalium seriatum *Fall.*
Eupactus obsoletus *Fall.*
atorama nigritulum *Lec.*
vexatum *Fall.*
gracile *Fall.*
confusum *Fall.*
dichroum *Fall.*
Dorcatoma dresdensis *Hbst.*
Protheca hispida *Lec.*
puberula *Lec.*
Eutylistis intermedius *Lec.*
incomptus *Lec.*
Cænocara bicolor *Germ.*
Ptilinus lobatus *Csy.*

BOSTRICHIDÆ.

Lichenophanes armiger *Lec.*
augustus *Csy.*
Dinoderus porcatus *Lec.*

SPHINDIDÆ.

Eurysphindus hirtus *Lec.*

SCARABÆIDÆ.

Atænius lecontei *Har.*
Hoplia trifasciata *Say.*
Lachnosterna marginalis *Lec.*
vehemens *Horn.*
balia *Say.*

CERAMBYCIDÆ.

Romaleum rufulum *Hald.*
Neoclytus capræa *Say.*
Cacoplia pullata *Hald.*

CHRYSOMELIDÆ.

Crioceris asparagi *Linn.*
Exema conspersa *Mann.*
Griburius larvatus *Newm.*
Cryptocephalus leucomelas *Suffr.*
Metachroma pallida *Say.*
Neobrotica dorsata *Say.*
Galeruca pomonæ *Scop.*
Phædromus paradoxus *Melsh.*
Crepidodera nitens *Horn.*
æsculi *Dury.*
Glyptina cyanipennis *Crotch.*
Phyllotreta lindahli *Dury.*
Chætocnema pulicaria *Cr.*
Cassida nigripes *Oliv.*

TENEBRIONIDÆ.

Merinus lævis *Oliv.*

Uloma mentalis *Horn.*
Lyphia ficicola *Muls.*
Arhenoplites viridipennis *Fabr.*

CISTELIDÆ.

Hymenorus discretus *Csy.*
Mycetochara rufipes *Lec.*

MELANDRYIDÆ.

Eustrophus confinis *Lec.*
brunneimarginatus *Dury.*
Hallomenus debilis *Lec.*

ANTHICIDÆ.

Xylophilus brunneipennis *Lec.*
melsheimeri *Lec.*
Anthicus currax *Champ.*

STYLOPIDÆ.

Acroschismus bowditchi *Pierce.*
duryi *Pierce.*
lugubris *Pierce.*

RHYNCHITIDÆ.

Rhynchites æratus *Say.*

CURCULIONIDÆ.

Exomias pellucidus *Boh.*
Apion segnipes *Say.*
nigrum *Hbst.*
pennsylvanicum *Boh.*
rostrum *Say*
Anthonomus gularis *Lec.*
elongatus *Lec.*
Piazorhinus pictus *Lec.*
Centorhynchus sericans *Lec.*
Cataspastus conspersus *Lec.*
Lymnobaris bracata *Csy.*
concurrens *Csy.*
Plesiobaris disjuncta *Csy.*

CALANDRIDÆ.

Pentarthrinus piceus *Csy.*

SCOLYTIDÆ.

Scolytus fagi *Walsh.*

INDEX.

*For *Coleoptera* not enumerated in this Index, see the special Index, pp. 191-196, Additions and Corrections on pp. 197-198, and Supplementary List, pp. 257-260.